PROCEEDINGS

Eighty-Seventh Annual Conference

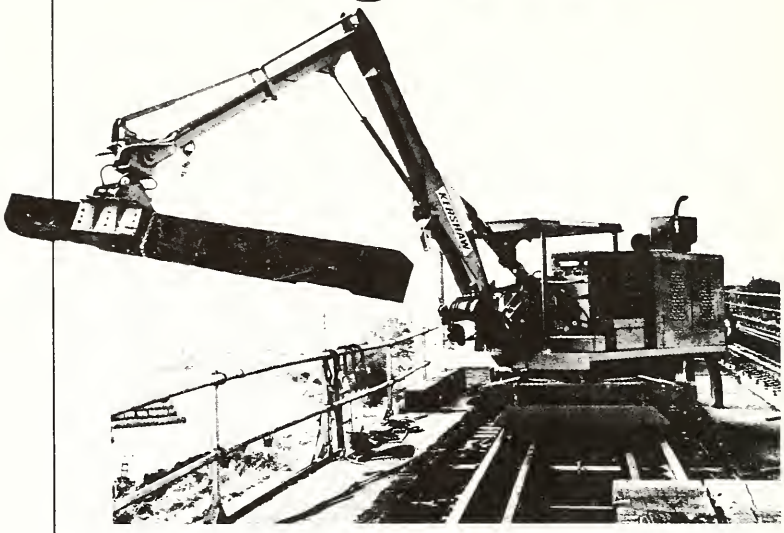
OF THE

American Railway

Bridge & Building Association

1982

The Bridge Crane



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Proceedings of the

Eighty-Seventh Annual Conference

of the

American Railway
Bridge & Building
Association

Held at

THE SUPERDOME

NEW ORLEANS, LOUISIANA

October 4–7, 1982

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Official opening of REMSA '82 by the four association presidents. Left to right: R. E. Haacke, AREA President; W. R. Hyma, ARB&B President; W. J. Gallagher, REMSA President; K. W. Sutherland, RMWA President.

NEW ORLEANS SUPERDOME welcomes REMSA '82 with over 130 inside exhibits and outside track exhibits at adjacent Union Terminal Passenger Station.

PROCEEDINGS

OPENING SESSION

Tuesday, October 5, 1982

The first Joint Session of the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge & Building Association was called to order at the Superdome, New Orleans, Louisiana, on Tuesday October 5, 1982 at 8:30 a.m., Mr. W. R. Hyma, President of American Railway Bridge & Building Association and Bridge Engineer Systems, AT&SF, Chicago, Illinois, presiding.

President W. R. Hyma: As President of the American Railway Bridge & Building Association, and on behalf of Mr. Sutherland, the President of the Roadmasters' and Maintenance of Way Association of America, I declare this, the 87th Annual Conference of the B & B Association and the 94th Annual Conference of the Roadmasters to be open in Joint Session.

At the outset of our deliberations, it is fitting and proper that we ask for Divine Guidance and for inspiration. I would like to call on the Reverend James Taglauer, Pastor of the First English Lutheran Church of New Orleans, for the Invocation. Reverend Taglauer.

Reverend James Taglauer:

Our Father in heaven, we praise you for your act of creation, by which you have shaped us with your own hands and breathed into us your Holy breath of life. Continue the presence of your Holy Spirit that we may be strengthened to live our lives as your children. Help us to be patient in the midst of adversity, always relying on your good pleasure for the welfare of your creation, and the benefit of mankind.

We pray for this convention, asking your Holy Angels to surround each participant in their travel as well as their stay in this city. May this gathering accomplish its objectives and demonstrate its improvability for the welfare of this country and its citizens. We pray that our meeting be an effective model of orderliness, faithfulness, and thanksgiving for each and every perfect gift which comes down from above, through Jesus Christ your Son, our Lord. Amen.

President Hyma: Thank you, Reverend Taglauer. As bridge builders we appreciate the need for a good foundation and you have given us a good foundation for our conference. You are welcome to stay with us, but if your schedule makes it necessary, please feel free to leave whenever you desire.

Ladies and gentlemen, members and guests, welcome to New Orleans, I particularly want to recognize our friends from the American Railway Engineering Association, who held a very successful regional meeting here yesterday, and also our guests who are here after attending the Second Heavy Haul Conference in Colorado Springs last week.

To those of you who have grown accustomed to always having this meeting in Chicago, it might be of interest to note that this is the fourth time that the B & B Association has met here in the Crescent City, although it is the first for the Roadmasters. In case you are wondering why you don't remember these meetings, the previous

meetings, for the B & B Association were 1895, 1916 and 1929.

You are all invited to attend all of the technical sessions of the Conference, and I am sure you will need no urging to visit the outstanding exhibits of the Railway Engineering and Maintenance Supply Association. I would ask that you please read your program through carefully so as to take full advantage of your time here.

For the ladies, registration is now underway in the Burgundy Room at the Hyatt Regency, with a special presentation, "Vignettes of New Orleans," at 2:00 o'clock this afternoon. Tomorrow there will be a guided tour and luncheon for the ladies, leaving the Hyatt Regency at 9:30 a.m.

As of 8:30 this morning the registration is Railroaders, 485; Associates, 632; Guests, 339; for a total of 1,456. Now, of special interest is the fact that this compares with a total of 1400 in Atlanta for the last show year, three years ago, at a comparable time.

At this time, I want to introduce those officers of the B & B Association who are seated at the head table and I would ask that you hold your applause until all are standing.

On my extreme right, Director, J. W. Davidson, Assistant Director of Bridge Engineering, Burlington-Northern, St. Paul; Director, J. T. Kapp, Staff Engineer, Construction, Conrail, Philadephia; J. N. Michel, Assistant Chief Engineer, Design, Amtrak, Washington, D.C.; Director, D. A. Bessey, Assistant Chief Engineer, Structures, Milwaukee Road, Chicago; Junior Vice-President, J. M. Williams, B & B Supervisor, Elgin-Joliet and Eastern Railway, Gary, Indiana; Junior Vice-President, J. Budzileni, Senior Structural Designer, Illinois-Central Gulf, Chicago; and Senior Vice-President O. C. Denz, Supervisor of Building Maintenance, Milwaukee Road, Chicago.

You may now applaud this dedicated and hard-working group. (Applause)

President Hyma: The remainder of our officers will be introduced at a later session.

Now, I will turn the rostrum over to my counterpart from the Roadmasters' and Maintenance of Way Association of America, President Karl Sutherland.

President Sutherland: Thank you, President Hyma.

It is a pleasure for me to join with President Hyma in welcoming fellow members of both Associations and all our guests to New Orleans and this 1982 Joint Conference.

We urge all of you to attend all sessions of this Conference and to participate in and to view the exhibits presented by REMSA '82. In doing this, you will gain the benefits of the excellent reports, presentations and speeches that will be made.

As you know, we have left all afternoons free for you to visit the REMSA exhibits at the Superdome and the New Orleans Union Passenger Terminal, so you should have no problem finding time to visit with your friends in the supply association and also be able to attend these meetings and to hear the reports of the committees.

You are all aware of the current economic conditions and the restrictions that have been placed by all companies pertaining to travel. Quite a number of our friends and members cannot be here with us today because of this, so we have the responsibility and it is our duty to take back home all the knowledge we can so we can do our job in a more capable manner.

At this time I'd like to present to you some of the members of the Executive Committee of the Roadmasters' Association whose diligent efforts have made this Conference possible. Those whose duties require their presence elsewhere will be introduced tomorrow morning. Will the gentlemen please stand as their names are called and remain standing until all have been introduced, and will you please withhold your applause until all have been introduced.

Beginning at my extreme left, Mr. Lester H. Kelley, Director, Assistant Chief Engineer, Maintenance of Way, Family Lines, Jacksonville, Florida; Mr. Ray E. Snyder, Director, Director Maintenance Operations, C&NW, Chicago; Mr. Mike J. Marlow, Director, Supervising Engineer, Tracks and Property, EJ&E, Joliet; Mr. Dave Staplin, Director, Director of Planning and Reporting, Family Lines, Jacksonville, Florida; Mr. Tom R. Rosamond, Director, Assistant Engineer of Track, Family Lines, Jacksonville, Florida; Mr. C. W. Moorman, Director, Division Engineer, Southern, Raleigh, North Carolina; R. V. Hernandez, First Vice-President, Track Production Manager,

Southern Pacific, Houston, Texas. You may now applaud. (Applause)

Greetings from the AREA

President Sutherland: Ladies and gentlemen, we are fortunate this morning to have with us the President of the American Railway Engineering Association. Most of us are AREA members and, as you know, their regional meeting was conducted here yesterday. It is my pleasure to present to you Mr. Roland Haacke, District Engineer, Union Pacific Railroad and President of AREA. Mr. Haacke. (Applause)

R. H. Haacke: Well, thank you President Sutherland, President Hyma, ladies and gentlemen. On behalf of the American Railway Engineering Association, it is indeed a pleasure to join with our sister organizations in a technical conference which is of interest and benefit to all of us.

In our fiercely competitve society nearly everyone wants to be first. We are assembled here this week for a first in our industry. We have REMSA, the Roadmasters, B & B, and the AREA. This is a dramatic demonstration of the cooperation which exists within the railroad industry and it just has to be a healthful, beneficial and productive association for these groups.

As was said before, which member of the group is the most important, as on a table or a chair, which leg is the most important?

America has been called the land of opportunity. We're all aware of the financial constraints under which we're currently operating and reference has just been made to that because of the absence of some of our friends and compatriots. So, again, in this land of opportunity we now have the opportunity to demonstrate that we can do well with one dollar what anybody could do with two.

And speaking of firsts, this is the first time in my life that I have ever been ahead of Bill Autry on anything. (Laughter). And Bill has cautioned me not to talk too long or cut into the time that he has allocated for jokes and humor and stories.

So with that, on with the show. Thank you. (Applause)

President Sutherland: Thank you, Mr. Haacke, for your comments, and we would be pleased to have you remain for all or some of our features, but feel free to leave when you wish as we know you have a busy schedule.

At this time, I would like to introduce Lou Cerny, the Executive Director of AREA. Lou, will you please stand and be recognized. (Applause)

Lou has very kindly volunteered to give us a brief talk on the upcoming changes in the FRA track safety standards. And this is not shown on your program guide. If you wish to make a note, Lou will do this tomorrow morning at about 10:30 at the beginning of the Roadmasters session. I know this is a subject in which most of you are very interested and I'm sure Lou's remarks will be most informative.

I now would like to turn the rostrum back to President Hyma.

President Hyma: Thank you, Karl. President Haacke, we are indeed honored to have you with us.

Greetings from REMSA

Another organization that is closely linked to our own is REMSA, the Railway Engineering Maintenance Suppliers Association. Their magnificent equipment display now underway is certainly the main attraction of this week. It is my pleasure to introduce Mr. W. J. Gallagher, President of the Sperry Rail Service and current President of REMSA. Mr. Gallagher. (Applause)

W. J. Gallagher: President Hyma, President Sutherland, special guests, ladies and gentlemen, I am honored, as President of REMSA, to be asked to join in welcoming you to the 94th Annual Conference of Roadmasters and the 87th Annual Conference of Bridge & Building. There are few groups in the association field that can boast of the longevity of the Roadmasters and Bridge & Building; in fact, it is extremely difficult to recall such continuity of service among associations in any other field.

At this time, I would like to present to Karl Sutherland, on behalf of our membership, REMSA's gold pin award which reads, "President, Roadmasters' and Maintenance of Way Association of America, 1981-1982."

President Sutherland: Thank you, Bill.

W. J. Gallagher: You're welcome. (Applause)

Also, to Walt Hyma I would like to present a matching pin which reads, "President, American Railway Bridge & Building Association, 1981-1982." Walt. (Applause)

Mr. Gallagher: It is our sincere desire to make your stay in New Orleans as pleasant as possible and the officers and directors of REMSA are at your service. If there is anything we can do to assist you, please do not hesitate to call on us. REMSA members are extremely proud of REMSA '82 and, as you know, the inside exhibit is in the dome and the outside equipment working on track is adjacent to the New Orleans Passenger Terminal.

We know that many of you are looking forward to the annual banquet Tuesday evening in the Regency Ballroom. Complimentary tickets, as usual, will be available for all registered railroad personnel and their wives. And you will hear a little more about the entertainment shortly. Thank you very much. (Applause)

President Hyma: Thank you, Mr. Gallagher.

We admire the faith that your organization has shown in the future of our railroad industry by going ahead with your exhibition in these troubled times.

Another friend from REMSA is their First Vice-President, Mr. Joseph Bush, from Jackson-Jordan, Incorporated. Mr. Bush, I believe you have some information for us. (Applause)

J. H. Bush: Presidents Sutherland and Hyma, special guests, ladies and gentlemen, sitting here waiting to come up, I noticed that Bill Autrey has a pocketwatch presented to him for outstanding engineering achievement in that 1929 meeting that President Hyma talked about. (Laughter)

Mr. Autrey: I'll get him for that.

Mr. Bush: I'll pay for that.

Members Invited to Banquet

Again, it's RESMA's pleasure to hold its annual banquet for the Roadmasters and Bridge & Building Associations in connection with their annual joint conference. It will be held in the Regency Ballroom, Tuesday evening, October 5th. For those of you who have been here several days, that's tonight. The doors will open at 6:30 with dinner to be served at 7:00. A musical trio will greet you at the door and this will be followed by dinner and a fast-paced program of entertainment.

I wonder who wrote that?

It is our aim that the festivities be concluded in time to permit all of you to spend some time Tuesday evening visiting with your friends in the suppliers' hospitality suites. Benny Sharpe will be with us again, and as most of you know, he's an old friend of the railroads and he's been a fixture at this annual affair for as long as I can remember. He will again be Master of Ceremonies with Dick Nelson, a famous comedian headliner, who really is good, and Gene Anderson featuring unusual and entertaining illusionists act. The Haywood Hamilton Orchestra with its Dixieland Group will provide the music.

I'm going to deviate from the script a little bit, and you'll be happy to know that it's for only 30 seconds, to not only thank all of you for attending, but I want you to know on behalf of the REMSA membership that we are aware and recognize that some of you made an extraordinary effort to get here. We appreciate it and thank you. We know that some of you are on vacation and that does not go unrecognized.

I do have one request. We do hope, because this banquet is an extremely expensive affair, and every year REMSA goes to bed with several tickets of "no shows," and it costs the organization thousands of dollars. I think those of you who are aware of this, that we pay for those tickets as soon as they are distributed and not turned in, and we hope that situation will not occur.

Those of you who will be in New Orleans, of course, tonight are certainly welcome and we are looking forward to seeing you there. Thank you very much. (Applause)

President Hyma: Thank you, Mr. Bush. The REMSA banquet is also the social highlight of our week and we are looking forward to Benny Sharpe's entertainment New Orleans style.

Introduction of W. S. Autrey

Speaking of highlights, at this time it is my privilege to introduce the keynote speaker

for our conference, William S. Autrey, Chief Engineer of the Atchison, Topeka and Santa Fe Railway Company. Mr. Autrey was born and raised in Jonesboro, Arkansas, and attended several universities during the course of World War II, including Denison, Swarthmore, Princeton, and he graduated from the University of Illinois with a Bachelor of Science Degree in Civil Engineering. He holds a Master's Degree from Massachusetts Institute of Technology. In his career on the Santa Fe he has touched all the bases: Roadway Assistant, Assistant Roadmaster, Roadmaster, Division Engineer, Regional Engineer, District Engineer, Assistant to the Chief Engineer and now, for the past twelve years, Chief Engineer of one of the premier railroads of the country.

With this background and as President of Roadmasters in 1974, President AREA in 1978, and as a member of the B & B Association since 1971, he has truly paid his dues and is one of our own. Some of you who recently attended the Heavy Haul Conference in Colorado Springs will also remember Mr. Autrey as keynote speaker of the first such conference in Perth, Australia, in 1978.

Personally, I can assure you he's a good man to work for; though I will admit that I don't always enjoy what he tells me, particularly in these times of austerity, I am looking forward to what he has to say to us today. It is my pleasure to present to you William S. Autrey. (Applause)

Management Must Look At Entire Picture

By W. S. AUTREY

Chief Engineer, Atcheson, Topeka & Santa Fe, Chicago

W. S. Autrey

Merci, Monsieur Hyma. Bonjour, monsieurs, madames et mademoiselles. Comme sommes vous? Fermez la fenetre et ouvrez la porte. I'm sorry, when I come to Louisiana I just seem to automatically lapse into French, and I apologize for that. (Laughter)

I can assure you it won't happen anymore. Not that I wouldn't like to keep on going in French, you understand, but I don't know any more. In fact, my wife tells me that I probably shouldn't even use that much because she says it's ridiculous to go around all day saying, "Open the window and close the door." (Laughter)

And for those of you who have had high school French, like I have, well, you know what I just said.

But, anyway, I would like to thank Walt Hyma for his invitation to participate in your meeting today, particularly since you decided to have it in the charming City of

New Orleans. Some of you know that my wife is a Louisiana French girl and she spent quite some time in this area, so I have a deep appreciation for Louisiana products. And speaking of those Louisiana products, the charming lady with the silver hair over here to my left is Chibsie, my wife. (Applause)

I don't think I should have done that. You see, there she goes again, she's stealing the limelight. You know, we've been coming to conferences like this for thirty some-odd years and I've gone in her shadow for all that time. A few years ago I was fortunate enough to be made President of the Roadmasters' Association and I thought: Finally, I'll get some recognition on my own and be recognized for myself. And so on the first day of the convention I got into the elevator with a couple of ladies and, sure enough, I saw their faces light up and I knew that they recognized me. I felt pretty good about it. And one of them said, "I know you, you're the husband of the President's wife." (Laughter)

So, it's always been thus, but, nonetheless, I'm glad to be here anyway.

I know that after completing the work associated with these sessions that many of you are going to be interested in sampling some of the culinary delights of New Orleans which will, no doubt, include crawfish etouffee, pompano en papillote, shrimp creole, okra gumbo, jambalaya, just to mention a few. And I'm sure that many of you have already done this and I hope you like those items as much as I do.

When I was approached by Mr. Hyma to come up here and talk to you people, we talked a little bit about what I might say and the amount of time I would have and so forth, and one thing he wanted to make sure of was that I wrote down what I was going to say because he said that he had noticed that I tended to become intoxicated with the exuberance of my own verbosity. So I have written it down but that's not always safe either.

Perhaps you've heard about the speech writer who worked for Lyndon Johnson and apparently he wasn't doing things just the way he should have been. So one day he came to work and he was told that this would be his last day. But he had one final job to do and that was to write a speech for the President to give in the Rose Garden before some group, the Daughters of the Golden West or the Campfire Girls or whatever. So when he gave these speeches he would use flip cards. And on the day that he was to make this speech he went into the Garden and started with the cards and saw the first one and it said, "They say we can't have guns and butter, but I say we can and I'm going to tell you how." He flipped that card over and the next one said, "They say we can't have peace with honor in Viet Nam, but I say we can and I'm going to tell you how." He flipped the next card over and it said, "They say we can't have a national health policy without soaring inflation, but I say we can and I'm going to tell you how." He flipped the next card and it said, "Now, Lyndon, you're on your own." (Laughter)

Now if I flipped one of these pages after a while and it says, "Now, Bill, you're on your own," well, we're all in trouble.

It says in the program that I'm here to make the Keynote Address. My interpretation of that assignment is that I'm simply supposed to talk in generalities and possibly discuss problems we have and actions that should be taken but not to provide any answers. Those answers are to be supplied by others on the program. A lot of good subjects are to be discussed by a number of very competent people. I look forward to hearing them over the next few days. I know that some of you have a tendency maybe to go out at night and stay out a little late, but I hope you will be able to stay awake to hear these people talk because they've got a lot of good knowledge.

It reminds me a little bit about the venturesome teenager from down south somewhere around New Orleans who decided it was time to make his maiden flight into the love-making department. And he went down to the local house of pleasure and pretty soon found himself in the sack with one of the most proficient and experienced ladies there. And he was trying to preserve a little romanticism in this first effort, so he said to the lady, "Tell me, baby, is I the first man who ever slept with you?" And she said, "Slept with me? Honey child, if you does you is!" Now, I won't say that if some of you doze off that you will be the first to have ever slept through something that I've had to say, but if you're going to nap, well it probably would

be better to nap while I'm talking than in front of some of these other people because they have a good message.

Meeting of Three Groups

While the Bridge and Building Association has been having its annual meeting with the Roadmasters for many years, I believe this is the first time these meetings have been held with a meeting of the American Railway Engineering Association, which held its regional meeting here yesterday. In addition to these three organizations, we also have the exhibits by REMSA, which is certainly a valuable addition to the meeting, and we've heard a lot about that already.

As engineering and maintenance people, I feel we can agree that these four organizations are probably the most meaningful and worthwhile entities around and we appreciate the work that's being done. I'm happy to say that I'm a member of three of these groups and would like to be a member of REMSA, but they say I'm not qualified to be a member of their group. So it appears I'll have to wait for that. I'm also a Past President of AREA and the Roadmasters, but I have had no success at all in my efforts to achieve that high office in the B & B. There are those who might say that the B & B people have more discriminating taste, but hopefully we can find some more plausible reason than that.

Speaking of those three organizations, I heard about the Presidents of those who went on a tour together into some of the countries where they are prone to have revolutions and, sure enough, while those three guys were there they had a revolution and these fellows were captured and, for some reason, were sentenced to be executed by a firing squad on three successive days. Well, the first man to be taken out to be executed was the President of the Bridge and Building Association, and he was put up against the wall and he was thinking, while this was going on, about the superstitious nature of the people there, and he figured out a way to get out of this. So when the commander of the firing squad gave the command, "Ready, aim, —" why this President yelled, "Earthquake." And sure enough those fellows dropped their rifles and headed for cover, so our friend got away.

Well, the Roadmaster was the next to go and he lined up against the wall and being a pretty sharp fellow like the Bridge man, he was also thinking about this, so when the commander said, "Ready, aim,—" he yelled, "Tornado." And, here again, they all headed for cover and he got away.

And now then the President of the AREA, being a very astute fellow, too, had observed this, so the next morning he went out and he was standing there and the commander gave the command, "Ready, aim—" and the President said, "Fire." (Laughter)

Now, I don't want Mr. Haacke to think that I'm talking particularly about him, because this was back in the olden days when fellows like Autrey or Sartore or somebody like that was president. (Laughter)

I've heard it said that a good speech must start with a quote from Dante, Socrates or Ben Franklin, but since my acquaintance with these gentlemen is somewhat limited, I'd like to use a quotation from one of my favorite philosophers, Baltasor Gracian, who wrote some rather profound words in the 17th Century, and among other things, Gracian said, "He is not a fool who commits foolishness, but he who having done so does not know how to conceal it. If your merits should be kept under seal, how much more your demerits? All men go wrong, but with this difference. The intelligent cover up what they have committed and the fools expose even what they make them." I think there's food for thought here so each of us can benefit from these words as we proceed with these meetings.

Again, it's good to be here and have the opportunity to appear before the Joint Session and to share with you some of my thoughts on our problems and opportunities as we face the challenges of today and the future. Mr. John Reed, our Santa Fe Chairman of the Board, has expressed reluctance to speak to groups such as this because we know the problems we're facing, and he feels his time is better spent addressing those with lesser knowledge, and I can certainly appreciate his position. But it's somewhat like the minister preaching to the choir, but the assumption is that we do need to have these discussions on occasion.

Each Association Must Contribute

Earlier I referred to our three professional organizations that are meeting here in a cooperative effort and I feel that this cooperation is so very important that each group attempt to contribute to the improving of our railroads. While the goals of each are somewhat similar, there is a distinction that requires a maintenance of individuality for each group.

The American Railway Engineering Association has a membership that includes railroad engineers from many and diverse interests, including those with interests in bridges and buildings, and also in the Roadmasters' responsibility for track work.

AREA publishes a manual of recommended practices and a portfolio of track work plans, among other things, and these designs and specifications are used extensively throughout our industry and in other areas and are most valuable. Members of the Bridge & Building Association and the Roadmasters' Association are the ones who use these specifications and designs to actually get the work done. There are, of course, many members of each of these groups who are members of one or more of the others, which is quite understandable since we are working so closely together. This we must do if we are to reach our goal of improving and maintaining our property in the most efficient way which results in the accomplishment of that task in the most economical manner.

REMSA is Important to Industry

Now, while I've been talking about the AREA, B & B Association, and the Roadmasters' Association working together, we're certainly mindful of the role played by REMSA in this saga of railroaders, their trials and their tribulations. REMSA is definitely a most important part of the picture and we appreciate very much their contributions as they provide us with the material and the equipment to enable us to do a better job. We continually ask our supply industry friends to give us better, faster, prettier, more reliable, tougher equipment and materials, and actually there are many more adjective modifiers we request and these supply people continue to come through when they are needed to help us in our never-ending task.

No doubt many of you have already visited the Superdome and have seen the exhibition and I'm sure all of us will do so before we leave here.

It's certainly a tribute to the innovative and creative people working in this industry and we are most appreciative. I think the President of REMSA is a good example of the kind of thinking that those people have to assure we have the ongoing progress that we have.

You take Mr. Gallagher, there, now—slim, trim, man with a good physique and he does this in spite of the fact that he's very fond of rich desserts. One of his very favorite desserts is pecan pie, very rich. Mr. Gallagher, being the kind of thinker that he is and the engineer that he is, knows that there's a lot of calories in pecan pie and he knows that calories are a unit of heat so he adds a scoop of ice cream to his pecan pie to cool off the calories and that's how he maintains his physique. (Laughter)

Well, I've been trying that but I've noticed that I've been adding a few pounds and it bothers me, but I think I've got the answer: I'm not using enough ice cream, so I'm going to start using two scoops and I believe then that I'll get to look like Mr. Gallagher and be a slim, trim gentleman like he is.

Another example of an energetic outstanding gentleman is Mr. Bush here. He has a lot of interests, a lot of enthusiasm in his work. Actually, some of you may not know that Mr. Bush has not always been in the railroad supply industry. As a matter of fact, he was going to be a farmer at one time, and he wanted to raise hogs. So he moved out to the farm and bought a sow and named her Clara Belle; and Joe, being a city boy, didn't know much about raising hogs so he asked his neighbor, "Now, what am I supposed to do now? I want to raise some hogs." So his neighbor said, "Well, the first thing you've got to do is to take Clara Belle over to another neighbor here who has a boar hog and leave her over there for a certain amount of time and then you're on your way."

So the next morning Joe and his wife got up and took Clara Belle and put her in a wheelbarrow and dropped her off at the neighbor's house and left her for a while and

then they loaded her back in the wheelbarrow and brought her back home again. Well, the next morning they rushed out to see if they had any little pigs, and they didn't have any. But that didn't bother them. So they loaded Clara Belle back into the wheelbarrow back over to the neighbor's house and left her a while longer again and brought her back home. The next morning they went out again, no little pigs. Well, they were still not going to give up, so they loaded Clara Belle back in the wheelbarrow, back over to the neighbor's house, and then back home again. Well, the next morning they weren't quite as enthusiastic this time, but Joe went out to the pen to see if they had any little pigs and his wife called, "Well, are there any pigs today?" And Joe said, "No, we don't have any pigs, but Clara Belle's sitting in the wheelbarrow." (Laughter)

I think we can agree that Clara Belle was taking an interest in the project. (Laughter)

And I think that REMSA members take an interest in their work in the same manner, and that's why we have such great people over there.

You know, in any group or any organization there's always one or two individuals that will kind of tarnish the reputation of that group, and I'm sorry to say that REMSA is no different, and I feel obligated to mention a couple of their members who should remain nameless to protect the innocent, or the guilty as the case may be. But due to the kind of deeds that they perform, I think that they ought to be known. Actually, it's a couple of Past Presidents, Owen Buscho and Jerry Hines are their names. I played golf with those two gentlemen last summer and we played through six holes and everything was fine. We were having a fine day.

Then, Mr. Buscho, who was keeping score, noticed that Mr. Hines had had 27 strokes, or 26 strokes it was, through six holes, and he complimented him on his fine golf game that he was having. He went on and on about it and it got rather monotonous and boring. For about 15 or 20 minutes he talked about that fine game that Mr. Hines was having. That really wasn't what bothered me so much. The thing that bothered me was that I had 27 strokes, one lousy stroke more than Mr. Hines did, and do you think they mentioned my golf game that I was having? Not one word about that! And that's what kind of upset me. But we used to go to these wildwest movies and, you know, the good guy always wins in the end.

In this case, when we got through with 18 holes the aforesaid Mr. Buscho had a score in the 90's, Mr. Hines had a score just under 90, and I had an 80. I didn't mean to mention that, I'm sorry. But being the kind of modest fellow that I am, I kind of let that slip out. (Laughter)

But, incidentally, if any of you haven't heard about it, I'll have time in the next two or three days to tell you about it, so feel free to call on me at any time.

Railroads Provide Efficient Transportation

But, back to work. In this recessionary period, I'm sure many of us have been a little discouraged as we've had to make adjustments in our program and so forth, but the fact remains that we, in the railroad industry, do provide a very efficient means for transporting goods and services. With the inherent advantages we possess and with the well-documented efficiencies of the steel wheel on the steel rail, I'm very optimistic about the future and feel that we will continue to be, and the future will become even more so a dominant force in the transportation industry on this continent. I feel that this is so because in this era of energy awareness and the emphasis on conservation, we certainly have the advantage over other freight modes since we use energy about four times more efficiently than trucks and about 60 times more efficiently than airplanes. Railroads also cause less damage to the environment than do other modes. Trucks emit nearly four times as many pollutants into the air as do trains on a ton-mile basis. Added to this advantage is the fact that one track has the potential to carry as much traffic as several lanes of highway.

As we look forward to assuming our place in the scheme of things, we must make certain we are prepared to handle the increased traffic over our railroads safely and efficiently. To do this will require the expertise of people like those gathered here today in solving the problems as they are presented to us.

We need to continually evaluate our practices and procedures and to make changes and improvements as conditions change and modifications are indicated. We've heard a lot of people say that if we're doing something the same way for five years it must be wrong and should be changed. I'm not sure I subscribe to that theory completely, but I certainly agree that we can't continue to do things as we have been simply because that's the way it's always been done. We should continually review and analyze and do the necessary to assure top level performance.

Meet and Solve New Problems

Railroads have faced problems from the beginning of our industry and we face problems today. These problems tend to change over the years, so we must be prepared to meet and solve these new problems as they develop. One problem that concerns me is not exactly new, but it keeps recurring in different forms, and that is the increasing axle or wheel loads.

We all know that we've had the 100-ton car with us for a long time and, while we in the engineering and maintenance fraternity would probably like to see the return of the 70-ton car along with the return of the nickel cup of coffee, the chance for these two events to occur is on a par with that proverbial snowball.

The trend seems to be towards moving more and more commodities in unit trains of 100-ton cars. These include coal, grain, potash, sulphur and others. And, then, we do have, of course, the many other 100-ton cars moving in mixed trains. We're told that from the traffic man's standpoint that these cars are very efficient and economical and we are, no doubt, going to have these cars with us from now on. But as good as they are, they do cause problems for us. We are very much in favor of the most efficient method of moving freight on our railroad, so if that's the way to do it, we'll face the problem and find the solutions.

Heavy Loads Make Bridges Vulnerable

When we talk about the detrimental results from heavy loads, we most often talk in terms of damage to the track. But we should not overlook the problems that arise in the maintenance of timber bridge which are rather common on many railroads. These problems which are associated with timber bridges are even more immediate than those associated with the rail, since the rail doesn't fail immediately but the crushing of the caps in the timber structures starts soon after the heavy loading begins.

Crushing of the caps takes place where the top of the piles bear against the underside of the cap and it occurs because the pressure exerted by the piles exceeds the cross-grain strength of the wood in the cap. The problem's first noted on bridges which have four-pile bents where 100-ton cars are operated, but as time goes by the caps in the five and six-pile bents also begin to fail.

In order to solve this problem and to provide a stronger structure, some roads have adopted the practice of replacing the timber caps with concrete caps and others have used steel. This is simply one illustration of what I'm talking about. And one of the needs to develop solutions to changing conditions.

As I mentioned earlier, the problem of heavy wheel loads keeps recurring, and another part of this that bothers me is the seeming tendency to continually attempt to increase what we now say should be the maximum by just a small percentage. As these loads have crept upward in the past, it's been accomplished in a rather innocuous manner.

Years ago we were handling 50-ton cars, then we went to 70-ton, then on up to 100-ton, even though the Joint Committee of Engineering and Mechanical Representatives recommended against that ruling on 36-inch wheels.

Now we hear about the desire to increase these loads by a few thousand pounds working upward in small increments. As in the past, on the assumption that we have successfully handled the given loads, so we should certainly handle the given and universally accepted loads plus a few thousand pounds. After all, it's only a few percentage points greater than the present approved loading. Surely we have a safety factor that will more than accommodate a few percentage points, don't we? We reluctantly agreed and we will try to increase loads and, lo and behold, we handled the heavier load without any immediate serious consequence.

Unusual Loads Become Usual

Now the increased loads which were somewhat unusual have become the usual and the accepted and we are ready to receive a proposal to again consider an overload of only a few thousand pounds or only a few percentage points, surely, et cetera and et cetera and et cetera.

Now, in spite of what I've just said, I repeat, that we are interested in the most efficient and economical approach to moving freight. But I also repeat that we, and all of railroad managements, must look at the entire picture and be aware of the effect on the railroad as a whole.

I know that some of our concern is that we are expected to accommodate this heavier traffic at higher speeds within the same budgetary framework as in the past. We must be able to sell the fact that while the larger and heavier equipment may be more efficient, there is a trade-off and some of the profits resulting from the greater efficiency must be allocated to the increased maintenance that results from its use. When this happens, I think we'll all be happy or be happier.

Last week the Second International Heavy Haul Conference was held in Colorado Springs where we discussed heavy-haul operations. There were delegates at this conference from all over the world and I'm happy to see that several of these delegates have been able to join us at our meetings here in New Orleans. As I said, the conference just concluded was the Second Heavy Haul Conference.

The first of these conferences was held in Perth, Austrailia, in 1978, and I was invited to participate in the program. It was a great experience from several standpoints, and I thoroughly enjoyed my stay in Perth, which is truly a magnificent city. The conference was also very successful and that success led to the decision to have the second conference in the United States which was just concluded.

When I learned that I was going to Australia for that first conference, I talked with Walt Hyma to get a few tips on what I might look for on the bridges in Australia, and he came up with what he thought was a better idea and suggested that he should accompany me since on some other trips I had failed to get enough pictures of bridge structures and to get the proper details in the pictures that I did take.

But since there was room for only one on the boat we had to give a lot of thought as to who would go and I was lucky enough to make it. Fortunately, Walt doesn't hold a grudge and he was kind enough to invite me here and I do appreciate that.

At this Heavy Haul Conference, representatives from several departments, including track, mechanical, operating and others discussed problems and proposed solutions associated with movement of heavy cars and also heavy-density traffic. Among the papers presented were several dealing with just what I've been talking about here; so I think we can see the interest shown, not only in this country, but throughout the world.

Information is Shared at Conferences

Sharing information at conferences like the one in Colorado Springs, just as sharing information here in New Orleans, will result in improved materials, products, practices and procedures that will benefit all of us.

I mentioned changes a little earlier and these changes are the things that have brought progress. Even change itself is changing, it's coming faster and faster. And how do we stay on top of these changes to make sure we are keeping up. One excellent way is to participate in professional society activities, attend the meetings and talk with others doing the same kind of work.

By following these practices, we can be aware of the latest thinking in our industry, and thereby win the respect of our men and of our associates. Since many of us are reluctant to make changes as we investigate and evaluate proposals, we must avoid the tendency to think of all the reasons why a new way won't work and look for one good reason why it might.

Over the next several days I'm sure many of us are going to hear new ideas and different practices that may be quite beneficial and cost effective. After all, that's why we're here spending our companies' money, and I think that money will be well spent if we follow some of the thinking expressed here.

I've talked about several subjects, but have not yet touched on what I consider to be one

of the most important—not one of the most, actually, but the most important asset any company can have, and that is it's people. One of Santa Fe's former Grand Division Chief Engineers, Joe Noble, wrote an article for *Railway Track & Structures* in 1966, and in that article was this statement:

> "Pretty early in my career I found out two things about running an organization.
>
> "One was that I couldn't make all of the decisions and do all of the work myself. The other, which I guess would naturally follow, was that my most importnat job was to guide and encourage the men working under my direction in such a way that they would use their talent and energies to help me. Maybe I was considering my own interest, as well as the company's in this thinking. Certainly it made things easier for me, but also, unquestionably, made the job better."

I think most of us can agree that that statement is as appropriate today as it was then, and certainly we must have the help of good people to perform at the ultimate.

Must be Flexible Managers

How we utilize our people today may be slightly different than it was twenty years ago, and we must be flexible enough, as managers, to develop our people and cause them to perform at the desired level. Some of you are almost as old as I am and we belong to a certain generation that has an outlook on life that's different than the generation now entering the work force.

Morris Massey, a psychologist from Texas, I believe, has made a presentation entitled, "You are what you are because of where you were when." Think about that. "You are what you are because of where you were when." Now, the theme of this presentation is that each generation feels differently and has a different set of values that must be recognized and properly dealt with if we are to be successful managers. I commend this work to you. I think you'll enjoy it.

Are in Business to Make Money

As we think about some of the things we are doing to improve our efficiency and our productivity looking toward the future goals of railroads in the transportation industry, all of us should carefully consider the question: Just why are we in business? The quick and easy answer is that the railroads are in business to run trains and move cars, but this is surely not the real reason. The reason for any private enterprise company to be in business is to make money and to provide a return on investment. The railroads are no exception, and we should all keep that fact uppermost in our minds as we work towards our goals.

Again, I repeat, all of us must be interested in the overall well being of our industry, and all departments must cooperate recognizing the contributions that must be made by each to achieve the goal of the most efficient operation that will result in the ultimate in profits to the company. With this cooperation, we can all look toward an exciting future in which our railroads will, indeed, be the backbone of the nation.

Thank you. (Applause)

President Hyma: Thank you, Bill, for a most appropriate and certainly a most enjoyable keynote address as I've heard.

I thought you were the only person to have been a president of both Roadmasters and AREA, but I did a little research and found that there were five others before you that held both, but no one's ever served as President of B & B Association along with these others. You say you are interested, I'll talk to our Nominating Committee. In fact, I head the Nominating Committee. (Laughter)

We would be honored to have you stay with us throughout the convention.

Now, the rest of our program this morning will include slide presentations, so I believe it would be best for those at the head table to take seats in the audience at this time except those that will be handling the introductions.

President Sutherland, I turn the rostrum back to you.

President Sutherland: Thank you, President Hyma.

I will now call on Ray Hernandez, First Vice-President of the Roadmasters to introduce our next speaker. Ray.

Introduction of A. H. Meyers

R. V. Hernandez: Thank you, Mr. President.

Our next speaker is a civil engineering graduate from the University of Houston. He began his railroad career with the Southern Pacific in Houston, Texas, in 1955 in the Engineering Department. He has been Assistant Division Engineer in San Antonio, Texas, and Portland, Oregon. He was promoted to and served as Division Engineer at Bakersfield, California, and Houston, Texas. He was promoted to Regional Engineer at Houston where he was instrumental in organizing the Englewood Rehabilitation Project. He is now the Assistant Engineer of Design and Construction for Southern Pacific Eastern Lines. He will speak on the rehabilitation of the Englewood Yard. Please welcome Mr. A. H. "Fred" Meyers. (Applause)

Rehabilitation of S. P.'s Englewood Yard

By A. H. MEYERS

Assistant Engineer, Design & Construction, Southern Pacific

Thank you, Ray.

On behalf of Southern Pacific and myself, I would like to thank the Association and this conference for the opportunity to present what we think is a very new approach in the rehabilitation of yards, particularly that of Englewood Yard.

Before I get into the presentation, though, I would like to assure everyone here and in other parts of the country that the economy of Texas and of Houston is probably not as good as you've heard, and this could be pointed out by an incident that happened in Houston a few weeks ago.

It seemed that two fellows from East Texas who had worked together for quite some time were unemployed and unable to find work and migrated to Houston with the rest of Detroit. After knocking on a few doors without any success, they ended up at the Texas Employment Commission in downtown Houston. And after standing in line, the first one went in and he came out a little bit later and he said, "We should have came here first, boy, I got a good job paying a whole lot more money than I thought I'd ever make." He said, "You go on and get yours and we'll get out and go celebrate."

So the second one walked in and the guy at the desk said, "Yes, what do you do?" And he said, "I'm a pulpwood cutter." And the guy said, "Well, you know, Texas is pretty much down and energy is bad and, anyway, you're in downtown Houston. We never have had any opportunity to place pulpwood cutters." And the guy said, "Well, you must because this friend of mine come in just before me and got a good job." So he said, "Well, let me look." So he looked and he said, "Yeah, but that guy's a pilot." He says, "I know it, but I've got to cut it before he can pile it." (Laughter)

A. H. Meyers

Englewood Yard was opened in 1956 and now provides service for more than one thousand industries in the Houston area and is a major yard serving another additional thousand industries along the Gulf Coast. In terms of handling traffic, Englewood is the largest of its kind in Texas. Sixty trains a day move in and out of Englewood and between five and six thousand freight cars are handled each day. This yard is capable of switching one thousand cars over the hump a day and, of course, works around the clock.

May we turn the lights off, whoever's doing it?

(Whereupon, there was a slide presentation with the accompanying remarks.)

The title of this is, "Rehabilitation of the Englewood Yard." This is somewhat of a misnomer in the fact that this talk is actually about the beautification of a portion of the Englewood Yard and not that of the entire yard.

When the decision was made to rehabilitate Englewood it was broken down into various phases, Phase I through Phase IX. What we are going to talk about today is Phases I through III.

Operation Delays to be Minimized

At the time these phases were being planned and the work carried out, time was the most important factor. Completing each phase of work in a scheduled amount of time and carrying Englewood's productivity with the least possible delay or having its humping operations shut down for a bare minimum of time, was the intent of this project in its planning.

Phase I would actually entail shutting down the humping operations of Englewood for a 24-hour period. Phase II would impair the humping operations of Englewood by taking out of service bowl tracks 33 through 64. And Phase III would impair the humping operations by taking out of service tracks 1 through 32. Both Phase II and III were planned to shut down for seven consecutive days on each phase.

As you can see, Phases I, II and III affect only the bowl and crest portions of Englewood. It did not impair the north yard or south yard, east yard, local yard or R-yard portions of Englewood.

We're going to talk about Phases I and II, first, and then go to Phase III. Phase I was scheduled to shut down humping operations for a 24-hour period. Phase I included the area from the first switch west of the lap switch below the master retarder eastward over the retarder crest to include the first three switches on the east side of the crest.

The total work project on Phase I included the following rail relaid. The rail was laid to the end of that portion of Phase I, including five turnouts, the scale and master retarder. The master retarder is 297 feet long and the rail relaid through the master retarder was pre-drilled, each rail having 108 holes. Also, during this project the 216 chairs were removed and replaced along with the shoe beam from the master retarder. We renewed all the signal cables. All the signal cables were replaced in underground conduits.

One lap switch was renewed. This lap switch is located just below the master retarder. There were four No. 7 turnouts, and one of these turnouts is located just west of the lap switch below the master and the other three would be on the east side of the crest. Repairs to the scale were made where needed.

We removed and replaced the subgrade. All the existing subgrade below the master retarder in that area encompassing Phase I was removed. This subgrade was replaced with 24 inches of cement stabilized shell. In Phase I we used approximately 770 tons of cement stabilized shell subgrade.

Completed Earlier than Planned

As stated earlier, our goal was to perform the above-mentioned work in 24 hours. We proceeded to try, working at 12:01 a.m. on Monday morning and completing all work and being back in operation at 10:00 p.m. Monday night, some 22 hours later.

Phase I entailed using approximately 78 laborers and equipment operators and these people were divided into two 12-hour shifts.

Phase II, as stated earlier, included the rehabilitation of the southmost bowl tracks or those tracks numbered from 33 through 64. Phase II was a much more ambitious undertaking. It took a great amount of planning and cooperation from every depart-

Phase I Construction

Phase II Construction

ment on the railroad. The Operating Department and Sales Department were greatly involved in adjusting for the Phase II shutdown and notifying customers of our project and how it would affect them. The following was work planned for the seven-day shutdown phase on Phase II.

Four group retarders were removed and repaired. Each of these group retarders were ninety feet long and were physically removed, sent out of the area and re-worked. Repairs were made on the retarders where needed. However, all the brake shoes were replaced and the group retarders were then restored to their original position after the subgrade work had been completed.

We renewed 20 No. 7 turnouts and renewed two No. 9 turnouts and renewed four lap switches. Now all these switches, turnouts and group retarders were on the east end of the bowl, and that's the end there that you see in the slide. We renewed 30 sets of switch ties on the west end of the bowl tracks and installed the 30 sets of switch ties along the lead. The 32-bowl tracks were retied with the installation of 33,000 crossties during the shut-down time.

We replaced the subgrade. Again, we removed the existing subgrade on the east end portion. Approximately 11,500 yards of material were removed and were replaced with 12,000 tons of cement stabilized shells.

On Phases II and III we placed 24 inches of cement stabilized shells under the group retarder and 18 inches under the rest of the area beyond the switch and the track tunnel areas. All the turnouts, lap switches, group retarders and the 32 bowl tracks were lined and surfaced. We also had people going through these bowl tracks replacing any broken rails and replacing and tightening bolts in the rail joints where needed.

To do all the work outlined above, it took a work force of approximately 600 people equally divided into two 12-hour shifts along with two work train crews on each shift. A contractor was used for the majority of the excavation of the existing material and replacement with the cement stabilized shell subgrade.

We had to bring in supervisors from all over the system and there was a supervisor with every important function of work going on in this entire project. We also had representatives from each railroad-equipment manufacturer who were a great help in working with our equipment people in keeping the machines functioning properly.

Housing and Feeding Large Force

In order to assemble such a large maintenance-of-way work-force, we had to bring in people from throughout the region. So motel accommodations were furnished and meals provided. Transportation from the motel to the job site was also furnished. Portable kitchens were set up at each end of the project and meals were furnished to the total work force on the job site.

Before work began on Phases II and III, a complete new drainage system was installed in the group retarder area either by open excavation or by boring. You'll see how far the installation of the drainage is in later slides.

Phase II began on a Monday morning at 12:01 a.m. and ended Sunday night at 8:00 p.m., four hours ahead of a seven-day completion time. The first group of slides we will see will be that of Phases I and II, combined, and then we will go to Phase III.

Establish Control Point

This slide shows our engineering control location. This platform was high enough to see over any and all work equipment and humping operations that were going on during this work. All the turnout and group retarder locations were referenced into this one engineering control point.

This is some of the pre-fab panel switches we had. These particular switches were used on Panel II. During Phases II and III each switch panel was numbered at the location and the rails were cut to the exact length.

Here's some more panel switches. This is actually on Phase I. These are located up on the crest.

This is one of our kitchen trailers we used to feed the people on the job site. This particular trailer was on the east end of the job.

Here's some of the excavation going on during Phase II. Some more of the work going on. You may see a side boom over there on the left-hand side. These two cranes were used for lifting the group retarders.

Group retarder renewed.

Phase III Construction

There they are getting ready to make the lift on one of the group retarders. Here they've got it in the air. Once they had it up and put it on this trailer the trailer then moved the group retarder down to the working area. They were unloaded and reworked and then brought back in after the subgrade had been completed.

Now, this particular trailer is rated at 1,000 tons and we didn't need the weight. What we needed was the length. And it looks like a centipede, it's got 144 wheels.

This is some more of the excavation going on. See the stock pile of ballast in the background. This is looking over Phase I in the back. More work going on in Phase II. This is a view from the crest of the work going on.

That same stock pile ballast you saw earlier is over on the left-hand side. We used that stock pile for placing under the switches and track panels on the east end of the project and under the retarder. On the west end we also had a stock pile and ballast that we loaded into ballast cars and then unloaded for the surfacing operations.

This is some more of the excavation going on. You can see the tie equipment in the background and spikers coming up behind it back there.

Had Heavy Rain

This is another shot from the crest. That's downtown Houston in the background. Now during Phase II we had a tropical depression come through Houston and we got about eight inches of rain in a very short period of time and then it continued to rain hard.

This particular picture is down at Seabrook, Texas, which is about 20 to 25 miles south of Houston. Our track runs across the picture from left to right. It's right in front of that blue car. This is right at the Seabrook Yacht Basin. Here's another picture just on the other side of the Seabrook Bridge. This is a cement sample that was washed out. See how sparsely our drainage was and this rain did not slow us down at all in Phase II; in fact, it seemed to cool things off. But we had other things going on besides Phase II at the same time.

Now this is Phase I and this is after the cement stabilization had been in place. Now

they're in there spreading the ballast so they can start laying track panels and switch panels.

There's a shot of Phase I. This is a shot of the group retarder. We like those shots—they hadn't looked like this for a long time. Another one.

During Phase II, the hardest task we had to accomplish during the seven-day shut-down was the inter-relation of the switch ties on the west end of the project. We compensated for that by sending down any additional available help we had any time to that end of the project.

Phase III covered the northern bowl tracks or those tracks known as Numbers 1 through 32. It was approximately one year between the ending of Phase II and the beginning of Phase III. The experience gained in Phase II resulted in changes. The 30 switches on the west end of the bowl track had been pre-paneled and laid prior to the shut-down time on Phase III. Also, all 32 bowl tracks had been re-tied prior to shut-down time. Therefore, during Phase III we renewed 20 No. 7 turnouts, two No. 9 turnouts, renewed four lap switches; repaired and replaced four group retarders, and replaced the subgrade.

Again, we replaced the subgrade by removing the existing material in Phase III. We replaced it with approximately 17,000 tons of cement stabilized shell. Again, a contractor was obtained to assist with the removal and excavation of the existing material and the placement of the cement stabilized shell.

Smaller Work Force Required

Due to the work accomplished before the actual shut-down time of Phase III, a work force of approximately 200 men was assembled, equally divided into two 12-hour shifts. All of the work on Phase III was accomplished in five days, or 48 hours ahead of the shut-down scheduled time.

Here are some Phase III slides. There is some more excavation going on there. Actually, we didn't have any rain during Phase III, but you can see how wet it is out there. Here you can see a part along our excavation.

All of the group retarders have been moved, and you'll see in the right-hand corner there, there is a man working on one of the group retarders. This one he's working on, is on the trailer. The last one, of course, was never unloaded, we worked it right on through to keep from having to. There's another shot.

Further along there you can see some dump trucks starting to haul the cement stabilized shell. By the way, do you notice those cranes? We had to go to a bigger crane in Phase III. The other cranes in Phase II just weren't big enough to handle it.

This is a shot taken from a helicopter. You can see that the cement stabilized shell is almost all in place at this point. Another shot, you can see where the panels were all laid out on the tracks ready to be put in place. They were all stacked prior to shut-down over to the left-hand side and then when we started work we brought them over and set them up on the tracks ahead of where they were going.

Now on the right-hand side you may be able to see two side winders bending over there laying a switch. I think maybe you can see it better in this slide. And that's how we laid all our switches.

Again, you can see a dump truck getting ready to dump in that long area that needs to be built. Another shot from the other side. Here you can see a part of it when it's further along. All the group retarders are in place and all of the switches west of them have been placed. This is the finished product taken from the crest on all three phases, I, II, and III. This is across the group retarder area.

And during Phases II and III all of the signal cable was renewed and put in underground conduits in this whole area. And in the area that we're looking at here there's about 60,000 feet of signal cable buried.

At the completion of Phases II and III all of the bowl tracks had been retied and surfaced, all the broken rails changed and bolts installed and tightened on all the rail joints.

We like these group-retarder shots. This is an area just below the master retarder, between the master retarder and the group retarders. Here's another shot of the crest.

Some of you may be wondering about any injuries during any of the phases. During

Phase III Complete

Phases I, II, and III complete.

Phase II we had a First Aid Station and a nurse on duty around the clock, and we did have some injuries that were treated on the job site and returned to work.

I don't remember any off-time injury on either Phases I, II or III. I do remember one injury that sticks out in my mind. On Phase II we had one fellow that O.D.'d on Gatorade. (Laughter)

May we have the lights up, please.

Again, I'd like to thank you for giving us the opportunity to present this rehabilitation project because we were quite proud of the outcome.

If you have any questions, I'd be glad to try to answer them.

Bob Hellweg (Retired Reg. Engr. GM&O & Amtrak): How much time went into the planning of this, probably years?

Mr. Meyers: I would say that for every day of work we probably spent a week of planning to get it organized. Logistics was one of the biggest things we had, getting the material in and out. Take ties in and old ties out and all of the material that we did use on the project. It took a lot of planning for everybody.

Mr. Hellweg: Is any of your yard rail welded?

Mr. Meyers: A few tracks, yes, but not all of them.

From The Floor: You show the one engineering station. Did you use your light mediums for that system?

Mr. Meyers: We used that system, and a distance meter and, I think, a D-2.

From The Floor: Everything was on the floor system?

Mr. Meyers: Yes, we had—everything was referenced in from that one point. Now, the elevations we did handle from the ground, but locations were all handled from that one point. That platform was driven—we could have boxed it in and used it for a bomb shelter. It was thick.

Mike Marlow: (EJ&E Railway): My question is: What type of equipment did they use on the engineering station and did they use forklifts?

I have one other question. Did you use any type of engineering fabrics?

Mr. Meyers: Yes, but we used it between the subgrade and the ballast on this project.

Mr. Marlow: Just under the turnouts and retarders?

Mr. Meyers: Yes, just on the turnouts and retarders.

Any more questions? (No Response)

Thank you. (Applause)

Mr. Hernandez: Thank you, Mr. Meyers. That was certainly a good presentation with a lot of valuable information. I hope you enjoyed it.

Now, I would like to turn the rostrum back over to Mr. Sutherland.

President Sutherland: I again would like to thank Mr. Meyers for his most pleasant presentation. It sure was a massive job and I know there are many yards that need the same work, so I'm sure that we have all learned from what has been shown here today.

I now return the rostrum to President Hyma.

President Hyma: Thank you, Karl. It's not on our program, but we have gotten a few minutes ahead and I think that we might all profit from a short break here, so why don't you take about ten minutes for a break and be back here and ready to go at 10:20.

(Whereupon, there was a brief recess.)

President Hyma: We will now continue with our program. I would like to call on Mr. J. N. Michel, one of the Senior Directors of the B & B Association, to introduce our next speaker. Jim.

Introduction of H. Longhelt

J. N. Michel: Our next speaker this morning is Mr. Herb Longhelt, Deputy Chief Engineer, National Operations with Amtrak, who will introduce a presentation on the "Redevelopment of Amtrak, Chicago Maintenance Facility."

Upon graduation from the University of Illinois in 1947, Herb went to work for the Illinois Central Railroad. He served in various locations from Iowa to Louisiana. Later, in 1969, he joined the Rock Island and then in 1971 he took his position with Amtrak. He is a former Director of AREA and has recently completed Chairmanship of AREA Committee 4, Rail.

At this time, it is my pleasure to introduce Mr. Herb Longhelt. (Applause)

Amtrak's Chicago Facilities

By H. F. LONGHELT

Deputy Chief Engineer, National Operations, Amtrak

Thank you, Jim.

It's just kind of like the games that are played in this stadium called football. Do you remember those? They had pro games and before the place kicker would make that crucial point. They'd call time out, so they called time out on me to put pressure on me, I guess.

There's a lot of boring things that come out of Washington and, hopefully, I'm not one of them. But they have a radio program I listen to driving home at night—no commuter service there on my side of town—and it's called, "Two For The Road." And they have a little thing called "Boring Facts." So I've got a boring fact for you this morning and that is that more years ago than I like to admit I did work for the Illinois Central down here in New Orleans—I almost said it like a Yankee, New *Or*leans. It's New Orleans. And where the Hyatt Regency is located now was the Division Office of the Illinois Central at 601 Loyola and where this stadium stands was an IC Yard and an Illinois Central Hospital. So, like I say, that's a boring fact. But my time here was very enjoyable and I got to know a lot of good Cajun people and New Orleans people. One thing I learned while I was down here was that the New Orleans people were very family oriented, very closely knit and they depended on one another to a very great extent.

One family had a young couple that was going to add to the number of the clan and the young lady was talking to her mother-in-law one day and she said, "I've decided to let Uncle Boudreaux name our baby." And the mother said, "Well, you know how Uncle Boudreaux is. He's kind of strange and he might come up with some very bad names." "Well," she said, "I've made the promise to Uncle Boudreaux to let him name our child."

H. F. Longhelt

So the young lady's days came about and she delivered twins. So, naturally, everybody was very interested to learn what Uncle Boudreaux had named the twins. The mother-in-law asked the girl, "What did Uncle Boudreaux name the twins?" She said, "Well, he named the little girl Denise." "Well, that's kind of nice. You know, maybe Uncle Boudreaux ain't as bad as I thought he was. So, what did he name the little boy?" She said, "He named him De-nephew." (Laughter)

And so much for the boring facts.

But shortly after I joined Amtrak I was asked by Roland Peak, Past President of the Roadmasters' and Maintenance of Way Association, to participate in the annual conference. And at that time I told Roland that I really didn't have anything to talk about and if Amtrak ever accomplished anything I'd be very agreeable to appear on a program. Now, don't misunderstand that we haven't done anything in ten years, and that's why I'm here now. But it's the first time that anybody asked me to appear on a program, so I was very happy to accept.

Amtrak has progressed remarkably in the short time that it's been operating, in my opinion. Compared to the railroad industry, it is hardly in the embryo stage. Still, although we are but a youngster, we have made good progress. During the past few years, Rich Johnson has been on a number of programs illustrating the work going on in the Northeast Corridor. And I'm sure that many of you have found interest in his presentations.

There is another side to Amtrak Engineering, however, with which some of you may not be quite as familiar. I know that a number of you Chief Engineers, Bill Autrey and the Missouri and Pacific and Kansas City Southern, and all these others are aware that every now and then we have a trip where we come out and try to start running on your railroad at a speed that you say you don't want us to run and then, finally, we get down to a point where they say: Come on, run, bring your pocketbook.

Own Many Facilities

But the other operation that we cover is the construction and maintenance of facilities that are owned by the railroads that contract to run our trains. And then we have also facilities throughout the United States that we own or lease and construct and maintain on our own, until at this point in time we have constructed 18 new stations, rehabilitated 114 miles of track from 60 miles an hour up to 79 miles an hour speeds, and either own or lease five yards and terminals off the corridor. These facilities are scattered from Los Angeles in the west to Albany, New York, in the northeast, and Miami in the southeast and from here in New Orleans to Chicago. As United Airlines says, "From ocean-to-ocean," we might add, "From border-to-border."

The design work for the stations and shop facilities which we built are prepared under the direction of Assistant Chief Engineer Jim Michel. Today, we are about to view a slide program which Jim has put together that will show you the Chicago Maintenance Facility.

Prior to Amtrak's 1976 decision to consolidate our Chicago operations, trains were serviced and made up at no less than five separate yards, even though Amtrak used one centralized passenger terminal, the Chicago Union Station. We recognized the need to eliminate costly and duplicate yard facilities. And the nearly catastrophic winter of 1976 turned this project into a Number One priority. I believe Jim has some slides that show cars with ice almost to the car floors.

The old Pennsylvania Railroad, later the Penn Central, Coach Yard at 12th Street and the former Pennsylvania Engine Facility at 16th Street, became the chosen site for the all new maintenance facility.

Leased Facilities are Run Down

This property was acquired by lease from Penn Central in January of 1976, and with subsequent ownership when Conrail was formed in April of that year. You will note, when you see the slide presentation, that what we acquired was certainly not worth bragging about. This is no reflection on the former owners as we all know that they were losing money on the passenger business and could not afford to keep up the facilities. That was a non-paying proposition. Among the many needed improvements were new service tracks and platforms to facilitate the movement, storage and provisions of trains. A top priority was to expand and modernize indoor facilities for maintenance of cars and locomotives during adverse weather conditions. A new crew base and commissary was another part of our plan.

These improvements had to be accomplished while the yard was still in use. As I said earlier, prior to these yard improvements our trains were serviced in five yards. These yards were the contract railroad's facilities in the Chicago area. Because the removal of the 12th Street facilities during construction would hamper our Mechanical Department's ability to service trains and because of contract problems in moving work from one yard to another, it was decided to lease the Santa Fe's 21st Street Coach Yard and perform all work with Amtrak employees at Brighton Park, 21st Street and the reduced 12th Street Yard. This eliminated the operation in the Milwaukee and B. N. Yards. Some temporary improvements were required at the 21st Street Yard to accommodate the additional load.

All of the track changes and new construction was performed in the new yard by Amtrak employees. Additional electricians, pipefitters and carpenters were also hired to make the necessary accommodations to existing facilities to allow the new construction. The R. T. Milord Company was the successful bidder on all of the major building components of this project.

With the completion of the 12th Street Yard, all other yards have been closed in the Chicago area which had been serving our coachyard needs.

After five years of design, construction and $43 million expenditure we think we have one of the finest, if not the finest, facilities for maintaining passenger trains in the country and, perhaps, the world. After reviewing this slide presentation, I hope you will share our feelings.

Thank you. Jim. (Applause)

(Whereupon, there was a film presentation which was written and produced by Mr. J. N. Michel and narrated by Mr. Jay Holmes, the voice-over accompanying the film.)

Voice of Jay Holmes: Increasing numbers of Americans are enjoying the convenience and comfort of traveling by train. These modern trains connect all parts of the United States over an extensive national network operated by Amtrak. The arrival at their destination is a pleasant finish to an exciting travel adventure.

The rush to disembark, the gathering of baggage, and the meeting of loved ones quickly passes. Soon the platform's clear and the station again quiet. Our train is but a ghost of its image of only a few moments ago. But as one story ends, another is about to begin.

To ready this passenger train for another journey requires the skills of many people and many hours of labor and a host of modern support facilities. Amtrak is proud to present its new Chicago Maintenance Facility, the finest passenger yard in the United States, for this is the story of, "The Renaissance at 12th Street."

To show you the many features of the new Chicago facility, we invite you to follow one train through the many steps that will inspect, service, repair and restock the equipment. Eight hours from now another group of passengers will gather at the gates of Track No. 28.

As the first step, the switch engine couples to the train. The switcher will pull the passenger cars from Union Station and turn them on the wye about one and a half miles south. Since this operation will take several minutes, let's briefly review the reasons why Amtrak invested $43 million for better inner city passenger service.

Servicing at Three Locations

In 1971 Amtrak assumed operation of most long-distance trains. It inherited four separate rail yards in Chicago, each operated by a different railroad company. It was not uncommon for a passenger car to require 48 hours to be switched between yards. As operations were consolidated over the years, all Amtrak departures were transferred to Chicago's Union Station and servicing was reduced to three locations. Penn Central 12th Street, Santa Fe 21st Street, and Brighton Park Turbo Shop.

Anticipating the creation of Conrail, Amtrak negotiated with Penn Central to take over 12th Street in October of 1975. This facility was the closest to Union Station and had very few commuter train responsibilities. The largest number of Amtrak trains were dispatched from this yard. The yard was the victim of years of neglect as passenger service was downgraded.

Severe Winter Hampers Maintenance

October quickly turned to November and one of the worst winters in Chicago history struck, depositing large amounts of snow. Weeks of below-freezing temperatures took their toll in water, air and steam lines. The drainage system was non-functional and the steam heat on the passenger cars condensed and literally froze equipment to the tracks. The result was the temporary suspension of a number of trains.

A decision was made to rebuild the yard facility. In June, 1976, Amtrak signed a five-year lease with the Santa Fe to use the 21st Street Yard as the primary service facility until a modernization could be completed.

This five-year lease created a critical completion in June, 1981, when all operations would again have to be shifted back to 12th Street. The program was composed of fourteen major contracts which resulted in a two-stage expansion of the engine house, a fourteen track coach yard, wheel trueing and car washing facilities, a waste water treatment plant, a car shop, a train inspection shelter, an engineering support building, and a combined commissary warehouse.

Let's check with the Yard Master and see where our train is. "John, how's No. 41's equipment doing?" "He's on the line right now. As soon as the train from St. Louis clears the junction, he'll be shoving back into the car wash." "Thanks, John."

Office in Tower

One of the major improvements of the yard is increased visibility by the Yard Masters. The old yard office had a small bay window which permitted the Yard Masters to see only a couple of tracks. The new office is 76 feet in the air and provides an unobstructed view from Union Station to 21st Street. The yard office provides blue flag protection and directs car and locomotive switching. The Yard Master also works closely with onboard services to get supplies, car attendants and food service workers aboard in time for departure.

While the train equipment is being turned, the locomotives are moved to the enginehouse. The re-development of the enginehouse was the first major project undertaken in 1977. Previously, fueling and watering of locomotives occurred outdoors. Phase 1 of the work enclosed this area providing three tracks with three locomotive positions each.

This structure was an extension of the existing engine house constructed by the Pennsylvania Railroad in 1946. The overall design was established at the outset so that Phase II could continue as funds became available. One of the more difficult tasks in designing and constructing the enginehouse were the poor soil conditions caused by random filling of an older barge slip on the Chicago River. This slip happened to coincide with the drop table pit.

Another major task was the relocation of a 48-inch city sewer around the building before construction could start. The enginehouse contains three distinct sections comprised of the fueling area, the running repair and service area, the latter being the old enginehouse with new utility systems and a new roof structure, and the heavy-repair section with overhead cranes and a 125-ton drop table. The floor plan of the building provides three 520-foot tracks for fueling and running maintenance, plus three tracks of varying lengths for heavy repairs.

Employee facilities are provided on the second floor. Administrative facilities are contained on the third floor.

Immediately adjacent to the enginehouse is a separate wheel trueing building, with an underfloor wheel lathe for in-place wheel profiling.

Our train is now ready to enter the exterior car wash, which incorporates a system designed and patented by Amtrak. Included is a water-recovery system to reduce washing expense and minimize the impact upon waste water treatment plant.

Waste Water Treatment Facilities

Let's take a quick look inside the wastewater treatment plant. The yard contains three drainage systems; one for storm water, another for sanitary waste, and, finally, an industrial waste system. The industrial waste water system collects shop floor and pit drainage, car washer overflow, and fuel spillage. This is treated through use of a dissolved air floatation process. The process first separates free oil in a large equalization tank and then adjusts pH and adds chemicals to remove emulsified oil. The end product is discharged into the Chicago municipal sanitary sewer.

Also in the waste-water plant is an area where chemical toilet service trucks are emptied.

The train is now being moved into the service and inspection shelter where most of the routine exterior work will be performed. The shelter contains two tracks, each 1200 feet long with folding pits for brake and wheel inspection. This is an extremely valuable building for handling the double-deck superliners which have an under car clearance of only eight inches. Other service operations include filling the drinking water

The car shop building contains 9 passenger car work stations on three tracks. Two single axle drop tables and full length jacking pads have been constructed. On top the car shop is the yardmaster's tower to direct all yard train movements. A total of 89,000 square feet is contained on five separate levels.

The heavy repair section of the enginehouse contains three tracks with a 125 ton full truck drop table, (2) overhead 15 ton cranes and service platforms and pits.

tanks and emptying the Amfleet chemical toilets, using an underfloor sewer manifold.

To speed removal of accumulated snow and ice prior to inspection, a steam radiant heat system in the pits is used. A gas-fired infrared system provides space heating. Each of the tracks in the shelter is provided with compressed-air brake outlets and 480-volt power to keep onboard heating, lighting, food refrigeration, and air conditioning operative.

Once the exterior work is complete the consist is switched to one of the other 12 yard tracks. Here interior cleaning and problems reported by train crews or those discovered during inspection are corrected. The coach yard is arranged with alternating vehicle and utility platforms. This permits access to every track by mechanical and commissary service trucks.

Tracks 8 through 14 can hold up to 18 cars and are split by a wide midway at the center. Train 480-volt power and compressed-air outlets are grouped on both sides of the midway. Located on the narrow platforms are utility cabinets providing 120-volt power, potable and non-potable water, and compressed air at every two car lengths.

The design of a water dispensing cabinet that would remain functional at 30 degrees below zero was perfected during the early stages of yard development. As a result, the Amtrak maintenance-of-way workers were able to construct the cabinets on a production line basis using the facilities of the engineering shop completed in 1979.

This building contains offices, employee facilities and shop space for the crafts responsible for fixed property and track maintenance.

Drainage Incorporates Undertrack Fabric

In the design of the yard extensive use of perforated drainage pipe and geotextile fabric was made to insure adequate surface drainage for years to come. In the diesel dispatch area, concrete slab track, with a new type direct fixation anchor, provides collection aprons under standing locomotives. All yard tracks are either continuously welded or huck bolted to reduce future maintenance. Train schedules require much of the work to be accomplished on the third shift, so high-mast sodium lighting has been installed to provide five to eight foot-candles of light throughout the yard.

Since much of this yard had to be built while maintaining daily train operations, three separate construction stages were employed. The first stage, tracks 8 to 12, was completed in 1977. This area was formerly a piggyback terminal and was clear of trackage when Amtrak took over. Immediately following were tracks 13 and 14 in 1978. Tracks one to seven were completed in 1981.

The interior car cleaners and mechanics then swarm over the equipment to get it ready for the evening departure. The carpets and seats are vacuumed, headrests and other paper products are replaced, the toilets are disinfected, the windows and sills are wiped down, brake equipment is tested and other passenger-car support systems are adjusted.

The Yardmaster has advised that two cars must be removed from our consist. Car 3104 is scheduled for a periodic extraordinary cleaning in which all the interior furnishings are cleaned or renewed. Part of that operation includes using a large blower that is placed at the end of the car to remove internal dust and debris. The other car, Coach 4616 has worn wheels which must be replaced. This work will be accomplished at the $4.2 million car shop. Two replacement cars of the same type will be placed in the consist from available cars in the Chicago pool. Prior to 1979, all car-repair work was performed outdoors under a shed.

The car shop contains 89,000 square feet of space on three floors. Three tracks run through the building, while a fourth serves as a wheel-release track. On two of the tracks two single-axle drop tables provide wheel changing capability plus jacking pads and pits. The third track is equipped with jacking pads only.

Support shops on the ground floor provide upholstery, carpentry, and machining capability. On the second floor, electrical components are repaired and locker, lunch room and toilet facilities for the car shop and coach yard are situated. On the third floor, the administrative offices, medical facility, radio shop and the security office are housed.

The coach yard has alternating wide roadway platforms and narrow utility platforms. High mast lighting with high pressure sodium fixtures provide five to eight footcandles of light in the 14 track yard.

An underfloor wheel truing machine is located in a separate building adjacent to the enginehouse. The diesel locomotive dispatch tracks on the right were constructed on concrete slabs to catch oil and grease drippings.

Monitor Panel Proves Invaluable

In the yard tower, just below the Yardmaster, is the central region control center and central monitor panel for the entire yard. This monitor panel has proved its value many times over by reducing overtime calls, alerting security personnel of unauthorized entry and identifying major equipment failures before they can cause catastrophic damage.

The microprocessor-based system utilizes a two-wire LOOP and digital transmitters to relay information. The monitoring requirements were developed by the Amtrak Engineeering Department and the majority of the wiring and components were installed by Amtrak forces.

The Chicago project was broken into two major areas of responsibility. First, the design and preparation of bidding documents by the Washington office; and, second, the supervision of Amtrak work gangs and inspection of contractor performed work by the resident engineer's office. Due to the limited time allocated to complete the project, 14 major contracts were awarded over a 42-month period.

The contracts for the enginehouse, car shop and commissary warehouse were set up as competitively bid, design-built packages. Architectural drawings were taken to 75 percent of normal completion by the Amtrak staff.

Structural, mechanical and electrical design were left to the bidders to complete using techniques and systems with which they were most competitive. Amtrak furnished detailed design criteria for these latter portions of the project. This approach permitted a reduction of the construction time of up to six months on each of these structures.

The site work and small buildings were designed and bid in the conventional plan and specification format. The track geometry was developed in the Washington office and the resident engineer performed the field layout. All track construction was accomplished using Amtrak track gangs.

This tight control resulted in the closing of the 21st Street Yard in May, 1981.

Handle Special Repair Work

As train departure time gets closer the pace of work increases. All of the routine jobs have been completed, but special repair jobs discovered during the inspection must be tended to before the train can depart.

A broken window must be replaced. On the last trip the train crew reported air-conditioning problems in the fourth car. This problem has been pinpointed to a defective valve which the mechanic is busily removing. A replacement valve has been ordered from the warehouse by telephone. The order clerk makes out a requisition which is dispatched to the storehouse by pneumatic tube, so the valve will be ready when the messenger arrives.

The warehouse occupies one half of the 124,000 square-foot commissary warehouse building.

About two and one half hours before departure, the commissary begins to assemble food orders. On the third floor, dry goods are stored in bulk and in gravity racks to allow the stock clerks to pick supplies for individual cars. The first floor contains the refrigerated storage and freezer space where bulk and preplated food products are stored. The supplies are loaded into metal food-service modules. The dry goods from the third floor are delivered by elevator and also put in service modules. The liquor kits are assembled and the soft drinks packaged.

All the modules for the entire order are then placed in the holding cooler to await the delivery. Meanwhile, on the second floor, food and car service employees begin to check in at the crew base. Approximately 90 minutes before departure the food modules are delivered to train side and the commissary workers and onboard employees stow the modules in the kitchen and snack bars.

The carmen and electricians now begin their final tests of electrical train lines and air brakes. The locomotives are brought from the enginehouse and put on the train. The head-end power for lights, heating and air conditioning are tested. When the car foreman is satisfied that all systems are properly working, he advises the Yardmaster to remove the blue flag protection. One of the

The Commissary Warehouse Building is equally divided between Material Control and On Board Services functions. This building is constructed of reinforced concrete frame with masonry walls covered by an insulated metal wall panel.

yard switchers is soon up against the train, air hoses are connected and the train is shoved into Union Station.

Today everything has gone like clockwork. The train is set 45 minutes before scheduled departure. The crews arrive, receive their manifests and board the train. Passengers are queueing. The newsstands are doing a brisk business selling papers and magazines. With 20 minutes to departure, the gates of Track 28 slide open and the passengers move briskly down the platform. They climb onboard and, finally, the conductor's highball marks the end of our story.

This has been only one episode in a story that repeats itself 27 times each day, 365 days each year. That is, perhaps, the most important attribute of the new Chicago Amtrak facility. Regardless of cold winds, deep snows, heavy rains, or stifling heat, the facility meets its commitment to provide Amtrak personnel with resources to make America's nationwide rail passenger system one of the finest transportation operations in the world. (Applause)

Mr. Longhelt: If there's any questions, I'll be glad to try to answer them for you, or I'm sure Jim can come up with all the facts and figures.

If not, we thank you for being a most appreciative audience. (Applause)

President Hyma: Thank you, Mr. Michel and Mr. Longhelt, for a most professional and interesting presentation. I think the absence of questions is only due to the completeness of the presentation.

Amtrak is doing some very fine work and we really do appreciate your coming here to share this information with us.

I've just been given the latest registration totals: railroaders, 548; associates, 652; guests, 406; for a total of 1,606. I would add, too, that the guest figure includes a lot of railroaders who are not members of one of the three organizations. So, again, this is keeping pace and slightly ahead of the pace of the registration three years ago.

President Sutherland.

President Sutherland: Thank you, President Hyma.

I will now call on C. W. Moorman, our Program Chairman, to introduce our next speaker.

C. W. Moorman: Thank you, President Sutherland.

Our next Special Feature is concerned with the construction of a Southern Railway facility in Atlanta, Georgia, for the processing and rewelding of released continuous welded rail. It's my pleasure to introduce our next speaker, Mr. P. R. Ogden, the Chief Engineer of System Gangs for the Southern Railway, which is one of the premier railroads in the country, to borrow Mr. Hyma's phrase.

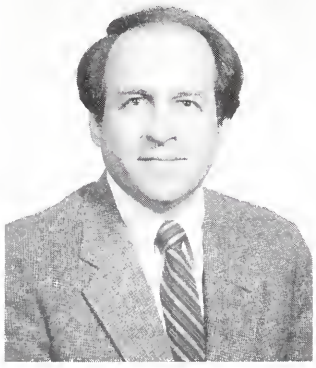
Upon graduation from VMI, with a Bachelor Degree in Civil Engineering, Mr. Ogden began his career with the Southern as a management trainee in Macon, Georgia. Since that time he has held the positions of Track Supervisor, Assistant Division Engineer, General Division Engineer of System Gangs, Division Engineer, Engineer of Maintenance of Way, and now his current position in Atlanta.

As one brief footnote, it's been rumored that while living in Kentucky, Mr. Ogden was a supporter of the Cincinnati Reds; however, I am happy to tell you that he's assured me that he's just like the rest of the south, he's always been a loyal fan of the Atlanta Braves. And with that in mind, would you please welcome Mr. Ogden. (Applause)

Rewelding of Released CWR

By P. R. OGDEN

Chief Engineeer, System Gangs, Southern



P. R. Ogden

Well, like Mr. Autrey said, you have to change after five years, so I guess—well, after a few years with Cincinnati, now bring on St. Louis. We're ready.

Most of us here today are responsible for track maintenance in some way for our respective companies and, thus, realize there is nothing more fundamental to a railroad than its track. Likewise, when we schedule our tie and rail-renewal and other maintenance programs, we are reminded that maintaining good track is a costly item for the railroad industry. It is because of this high cost to maintain our track structures that maintenance-of-way personnel must always be searching for a better way. Material and labor will continue to increase, and the only

way to offset this is to develop better material with longer life, increase production and decrease labor.

To help in this process of reducing the maintenance cost on the Southern, in Atlanta, at Inman Yard we have a track-assembly-and-welding plant which consists of several different facilities performing a number of functions to produce continuous welded rail and prefab track structures. This plant had its initial conception in 1957 building track panels for the construction of Inman Yard. Since its beginning there have been many changes and additions.

Facility Includes Several Plants

The plant today is equipped to perform many different functions used in mechanization that allows the company to benefit from the increased efficiency of handling the large quantities of material that goes into the track structure. The facility today could be categorized into the following plants: track panel plant, switch slab, cropping yard, welding plant, reweld plant, and a 78-foot rail facility.

The reweld plant is my topic today, but the existing track facilities at Inman Yard had some influence on the construction of this plant, so I would like to briefly outline the existing facilities and their functions.

Each of the different facilities is dependent upon at least one or more of the other facilities. For example, the panel plant and switch slab are dependent upon the cropping yard for rail cut and drilled to proper dimensions; therefore, to obtain maximum efficiency each addition has been integrated with the previous existing facility.

(Whereupon, there was a slide presentation with the accompanying remarks.)

Track panels are built using a Link Belt conveyor to properly space the cross ties and air hammers for spiking. Tie plates and spikes are handled with an overhead crane. The rail is moved, by conveyor, as needed from the cropping yard. Once the track panels are built they are loaded into special panel cars and shipped to designated locations over the system.

Panel switches are constructed on a concrete slab adjacent to the panel plant. An overhead crane is used to handle all switch material. The switches are loaded by use of an overhead crane on to special turnout cars for shipment to locations over the Southern System.

When jointed rail is released in the field it is loaded in strands of 1440 feet onto the rail train and transported to Atlanta for dismantling. The rail is propelled by a rail pusher from the storage rack to a bolt-removal machine, which is a multiple-spindle machine internally designed and constructed to remove all bolts and joint bars. Bolts and joint bars are moved by a conveyor to a gondola.

The dismantled rail now moves by conveyor to the cropping yard. The cropping yard consists of a press, saw and drill. The press is a four-way hydraulic machine which removes vertical and horizontal kinks.

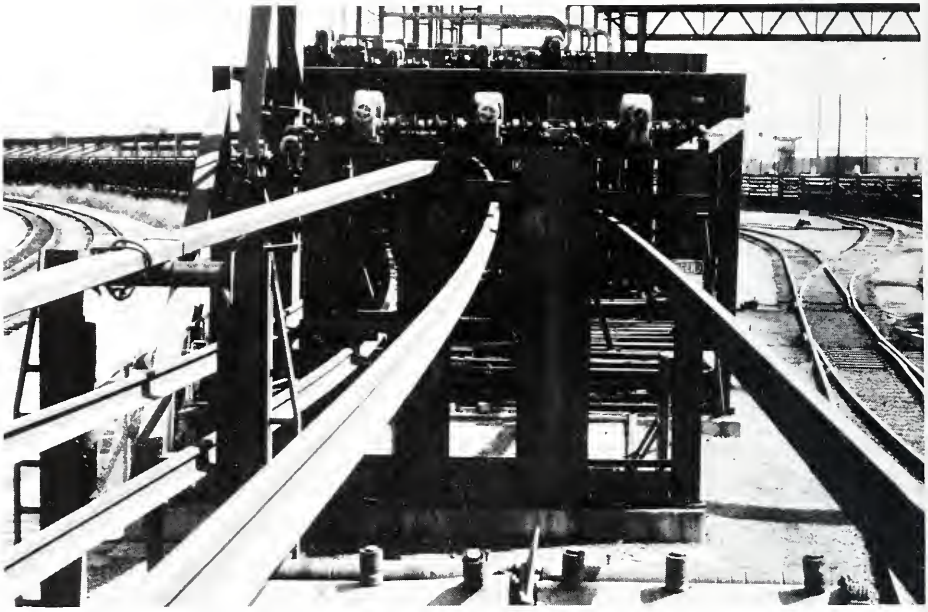
After straightening, the rail moves to the saw house. Here a friction saw is used to crop off rail ends of relay rail. The rail now moves to the drill house for redrilling, if needed. The drilling is done with a multiple-spindle drill. All maintenance rail and end-rails for strands of continuous welded rail are drilled.

All of these facilities have an important role in our overall maintenance program, but the welding plant is the most active. The first welding plant was initially set up in 1958 at Inman Yard and consisted of portable welders mounted in boxcars.

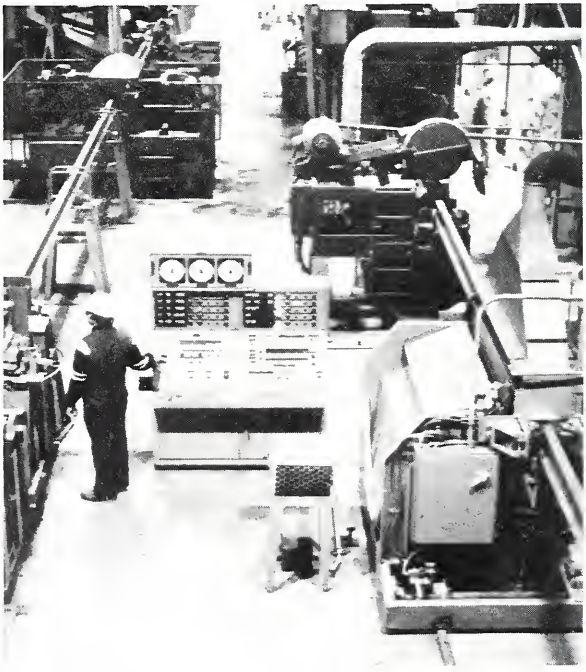
This plant, as you see here, is the result of a number of changes since 1958, the most recent one in 1980 with the purchase of new welding machines. The welding plant is equipped with all the complementary equipment that is needed for an efficient operation, such as automatic rail polishers, welding machines, semi-automatic base grinders, rail pushers and inspectors.

Add a Reweld Plant

In 1979 we added another facility which is my topic of discussion here today, and one we, on the Southern, call the Reweld Plant. This is a facility which allows released welded rail to be moved from the point of release by a rail train in strand lengths of 1440 feet to the Atlanta Plant where it is reclassified, processed, rewelded, and shipped back out for relaying.



Released worn CWR moving simultaneously from rail train to storage rack, storage rack to reweld plant and reweld plant back to storage rack.



Reweld Plant — released CWR measured for wear, processed and rewelded.

The first welded rail was laid on the Southern property in 1959. At the end of 1981 there were 7,400 track miles of welded rail. In 1973 the first released welded rail, a total of 10.4 miles, was cascaded down from one of the heavy-tonnage main lines for reuse on a track with much less tonnage.

At this time a need for a facility to reclaim, process and reweld this type of rail was recognized. In order to develop the idea, it was researched throughout the railroad industry in the United States and Europe relative to the equipment and physical layout that should be incorporated in a reweld plant.

What we found was that there was no facility in existence like the one we had in mind. There was no plant in the world equipped to bring released welded rail in from the field in strands of 1440 feet, reclassify, process by removing all joint bars, crop rail ends, cut out defects and thermite welds, reweld and ship back out to another rail relay location.

Everyone was doing as we were, cascading the relase welded rail down with any reprocessing done on the heads of cross ties. Any welding done, once cascaded down, was of the field thermite type, which is an expensive weld compared to a plant weld.

As the use of released welded rail continued to escalate after 1973, as shown by this chart, the need for a facility to process this rail before relaying increased. After a great deal of research, coupled with the expectation of releasing 150 to 200 miles per year of reuseable release welded rail, Southern in 1979 made a commitment to build a plant to reprocess and reweld this type rail. The project was turned over to our engineering people to design and construct with input from the maintenance-of-way people who would be responsible for operating the plant.

The objective was to design a facility that would allow the release welded rail to be reclaimed in a methodical process with emphasis on mechanization, reducing the labor intensive method of reprocessing this rail on the heads of cross ties, and eliminating field welding to remove joints. The facility had to be one that could handle rail in strands of 1440 feet, reprocess by removing all joint bars, crop ends of rail, remove defective rail and rail kinks, classify the rail with respect to wear, reweld and ship back out again as a strand of continuous welded rail 1440 feet in length.

A facility designed to meet this objective would allow our company to better take advantage of the economics of reusing this release welded rail, to carry out a program to upgrade the secondary branch lines, yards and sidings. Although this rail, for various reasons, is no longer good for the heavy tonnage lines, it has many years of life remaining on a secondary type line with less tonnage and speed.

To take advantage and get maximum use of the existing facility at Inman Yard, a decision was made that the new facility had to be in the immediate vicinity. This presented the engineers with the first major obstacle because space is very limited; therefore, the new plant had to be designed, not only with the capability to successfully process the long strands of rail, but it had to fit in the available space. Because jointed rail is also shipped to Atlanta for dismantling, another decision was the storage rack for the new plant would have to be integrated with the storage rack for jointed rail.

The commitment was made in 1979 with funds authorized for the construction of the plant. The project had to be completed in 1979. It was completed on time and within budget, but I can assure you that during the process there were a number of engineering problems that arose and at the time appeared to be almost insurmountable.

In some respects the reweld plant is similar to other welding plants relative to the equipment used. The welding is done with an electric-flash welding machine and some other equipment, such as the rail pushers, rail saws, rail polishers, base grinder and hydraulic presses, are used in most welding plants.

There are areas, though, where the facility deviates from any conventional welding plant. To our knowledge, it is the first plant in existence where rail in lengths up to 1440 feet are welded. The rail is also electronically measured for wear and reclassified before welding so that each strand of rail leaving the plant will be of all the same type rail. This also allows us to selectively reassign the rail for reuse based on wear limits to assure that

the rail is reassigned to a rail location that will most benefit the railroad.

Sequence of Operations

That is somewhat the history and thinking which led Southern into making the commitment into building the reweld plant. To describe the plant and its operations I will outline each step the rail follows, from the point of being released to the point of reuse.

The rail is released in the rail program by one of two rail gangs using the dual rail laying system. The release welded rail is loaded back into a rail train each day on the second shift. When a train of rail is laid, a train of released welded rail is loaded and moved to Atlanta to the reweld facility.

Rail, upon arrival at Atlanta, is unloaded from the rail train onto a storage rack. The rail pusher with the train propels the rail from the train onto the storage rack. The storage rack is designed to hold 216 strands of rail, jointed or welded, which is equivalent to four train loads or 30 miles of rail.

The rail-guide system is one of enclosed rollers with the mobility to move horizontally and vertically. The guide system is designed to move four strands of rail at the same time. Two strands from the train into the storage rack, or just the reverse, two strands from the storage rack onto the train. A third strand will move from the storage rack to the reweld facility. A fourth strand will move from the reweld facility back to the storage rack. The rail is guided through the storage rack with rail-end shoes which are removed after loading and returned to the incoming end of the storage rack by means of a battery powered cart which is self-guided under the rail rack.

Once the rail is placed in the storage rack, the next step is to move it to the reweld plant by, again, passing through the movable-roller guide system into a series of fixed enclosed rollers. The rail is now ready to enter the reweld plant.

Two Production Lines Used

The reweld plant is enclosed in a prefabricated steel building 200 feet long, 31 feet wide, and 22 feet high. The building has a 10-ton overhead crane with 180-foot craneway capable of serving all of the production lines. There are two production lines, one to process the rail by removing joints, defects and classify the rail for reuse, and one line for welding.

I'll take just a second over here to explain that. (Indicating slide.) The rail train comes in here on this track and stops right here at the storage rack. The rail is then unloaded from the train back onto the storage rack, comes back down the rack through the rollers, the guide system. This is the reweld plant building that we just saw on the previous slide. The rail enters the building here at the—through what we call the process line and goes through a traverse conveyor back into the classification storage rack and then will come back through the building to what we call our welding line. These are our two process lines.

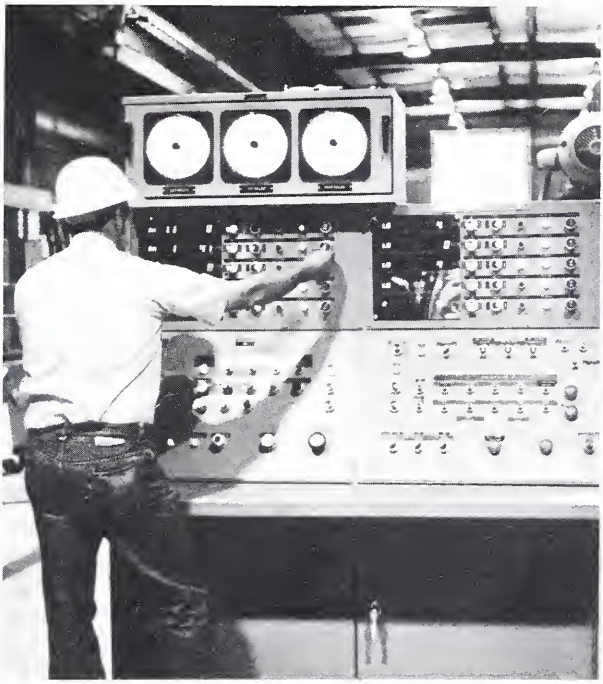
At the entrance of the reweld plant the rail passes through a scraper to remove dirt and grease. The rail now enters the building and passes through the process line. The process line consists of two rail pushers, a rail straightener, a classification station, a machine for rail-flow removal, joint bar removal and a rail saw.

The rail pushers, which propel the rail through the plant, are the standard hydraulic-type units normally found in a rail-welding plant and are synchronized together. There are five locations from which the pushers can be controlled, but can only be controlled by one location at a time. Each pusher is capable of exerting 20,000 pounds of thrust and can move the rail at variable speeds from zero to 100 feet per minute.

After the rail pusher, a hydraulic press has been provided to remove verticle and horizontal rail kinks. This is also a standard type unit found in most welding plants.

Rail is Classified into Four Classes

From the hydraulic press the rail moves to the classification station, which is the main control station for the operation of the plant. At this station an assistant supervisor controls the process line classifying the rail into four classifications: main line, secondary, yard and industry or scrap. Upon entering the classification station the rail passes



Control station — measures rail wear, automatically controls processing line and keeps a running inventory of difference classification of rail in storage table.

Rail Traverse — guides rail from reweld plant to a pre-determined pocket in the classification storage table.

through detectors which sense whether a joint bar or thermit weld are present.

After passing these detectors, the rail passes through three sets of rollers, measuring the rail for wear. The measuring rollers are referenced from the rail based bottom and determine rail wear on both sides and top of rail column. This information is then transmitted electronically to cam-limit switches and a fractional dial-indicator on the inspector's console shown here.

From this console the inspector controls the entire process line. As the rail moves through the measuring stations, if any detectors are tripped or rail classification changes are sensed the rail is immediately stopped and the appropriate indicator is illuminated at the inspector's console. Upon examination of the console indicator the inspector determines whether a rail change has occurred or a joint bar or thermit weld is present.

If a joint bar is indicated, the inspector makes the appropriate decision and the rail is released to travel to the joint bar dismantling station, processed and continues to the saw for rail-end removal. If a thermit weld is indicated, a similar action is taken by the inspector, except that the rail goes directly to the saw for weld removal.

When a rail classification change is indicated, the inspector goes to class change actually present, main line, secondary, yard and industry or scrap. At this point the inspector must visually inspect the dial indicator and the rail to determine if, in reality, a change is warranted. If the inspector determines that a change has occurred he must then decide to confirm the change indicated, whether the rail is worn right side or left side and what storage slot or scrap table the rail is to be directed. After these items have been determined, the rail is released to proceed to the next station.

At all times rail ends are tracked and recorded as to disposition and displayed both at the inspector's console and the welder's console so that each has instant information as to the type rail, amount and number of pieces in each slot of the classification table. This is accomplished with the aid of a programmable controller which has approximately 6,000 instructions stored in the controller's memory.

Has a Special Rail Grinder

From the classification station the rail moves to rail grinder. When the rail has a metal overflow on the ball in excess of one-quarter of an inch where a weld is to be made, the metal overflow prevents the shears in the welding machine from adequately removing all of the upset metal. This overflow has to be removed and is accomplished with the rail grinder which was designed and built especially for this plant.

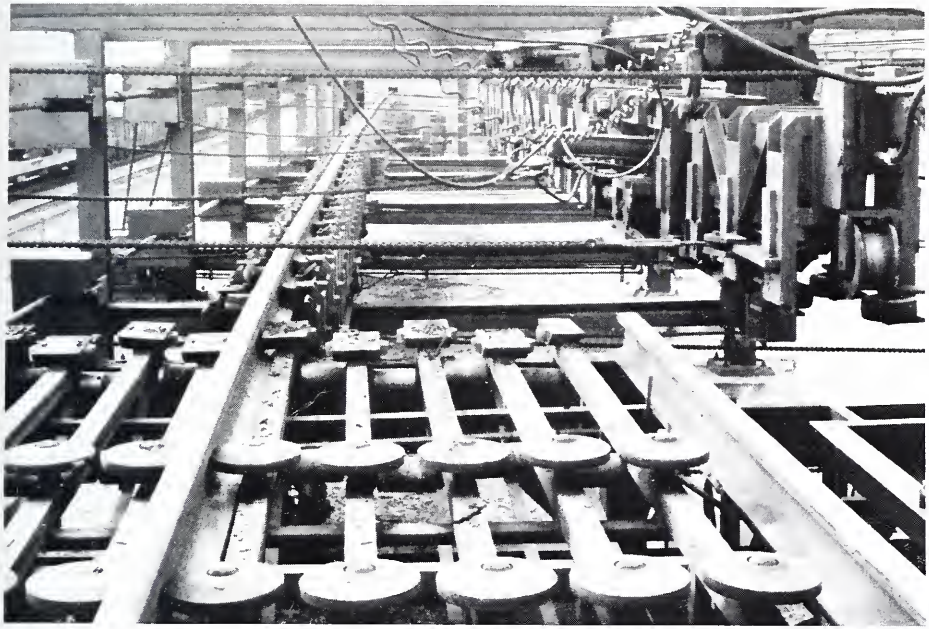
The machine features an automatic grinding cycle for removing rail-overflow from the right side, left side, or both sides of the rail head to within one thirty-second of an inch of the parent metal. This is done by clamping the rail and proceeding to grind it by consistently probing and indexing the grinding heads until the desired results have been achieved. This machine has the capability of removing one-half inch of metal for 20 inches from the rail ends in 90 seconds or less.

The next step is a joint-bar dismantling station. The rail is automatically stopped at this station by the controller at the classification station. An air-impact wrench is used to remove all bolts. Bolts and joint bars are placed on the conveyor and move outside the building, where they are collected for reuse.

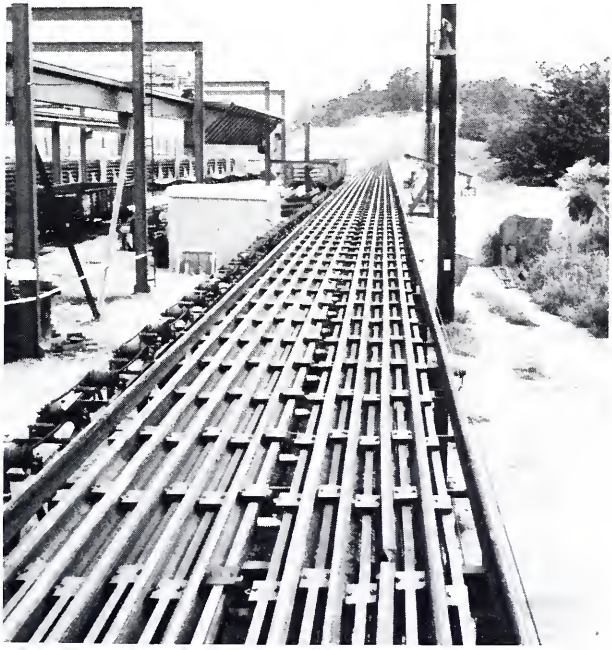
Next in line is the rail saw. The saw is an abrasive type designed and built internally. The rail is stopped automatically at this station and also by the controller for all cuts designated by the inspector at the classification station. All crops, scrap rail ends are moved by the conveyor out of the building and are loaded onto a gondola by an overhead crane. The rail has now been straightened, classified, rail flow removed at ends of rail, joint bars removed, rail ends cropped, field thermit welds removed and other rail defects cut out.

Conveyor System is Unique

The rail leaves the plant propelled by the outgoing pusher through the rail traverse conveyor. This conveyor system is unique, as seen here. It guides the rail into a predetermined pocket in the classification table and returns the rail back to the building for re-



Released welded rail leaving classification storage table moving into the plant for rewelding into a continuous strand of 1440′.



Classification Storage Table — after reclassification, rail is collected in one of 10 pockets, each 1445′ in length, before rewelding.

welding. If any rail is classified as scrap, the rail traverse also directs the rail into a scrap conveyor which moves the rail to a transfer table and is ultimately loaded into a gondola by an overhead crane.

This rail traverse system was designed and constructed at the Southern Charlotte Roadway Shop. The traverse is controlled from the classification station for rail moving into the classification storage table. And from the welder's station, the rail moving from the storage area back into the plant for welding.

There are two traverse conveyors, an upper and lower. The upper traverse moves rail onto the classification storage table and the lower traverse guides the rail from the table back into the building for welding. Space was very limited for this project and this was an area where the design engineers had to use a lot of imagination and ingenuity. The traverse had to be designed to move the rail to the building into one of ten pre-determined slots in a distance of 130 feet.

To ease the transition from the upper traverse to the storage table, the first ten feet of the table was designed so that each of the ten slots could be raised three inches. The classification storage table consists of ten slots, each 1460 feet long.

We now have the rail in place for welding. The operator at the welding station now controls the flow of rail. He chooses the type rail and slot to take the rail from by the information displayed on a console at his station. The console will tell him, at all times, the type rail, number of pieces and length in each slot.

To move the rail from the classification table back into the building for welding the lower traverse conveyor is moved into place by the operator at the welding station. The rail is pushed into the building by the use of a cable-driven cart which is synchronized with the incoming pusher on the welding line. The rail is now moving back into the building for welding.

The welding line consists of two pushers, rail-end polisher, welder, abrasive saw, rail base-grinder, post-weld straightener, finish grinding and inspection station and rail end drill. This is all equipment that you would expect to find in any welding plant.

The rail moves through the welding line propelled by the incoming rail pusher, which is the same as previously seen in the process line. The first stop will be the rail-end polisher. This is a semi-automatic machine using flapper-type polishing wheels to remove oxidation, dirt and grease from the base and head of rail where it makes contact with the electrodes in the welding machine.

From the rail polisher the rail moves into the welding machine. This is an electric flash-butt rail-welding machine of the same type used int he welding plant. The machine features include an automatic clamping, aligning, welding and shearing sequence. It is also equipped with an automatic, post-heating cycle for alloy rail.

After the welding machine, there's a rail saw. This saw is necessary to remove any welds that do not meet our requirements for a good weld. This is an abrasive-type saw, same as the one in the process line.

The next machine in this line is a base grinder. This machine is used for removing the upset metal from the base of rail. The machine uses a ten-inch grinding wheel with automatic depth control and a seven-inch stroke.

From the base grinder, the rail moves to a post-weld straightener. This machine is a four-way hydraulic unit, same as the one previously described in the process line.

Weld is Carefully Inspected

Next is the inspection station, which is a very important part of the welding line. An assistant supervisor operates from this station, monitoring all welds on an oscilloscope graph. All welds are monitored for pre-heat impulses, flash time, upset and platen travel. If a weld fails to meet any one requirement, it is rejected as bad. This inspector also does the finish grinding on the ball of rail and makes a magnetic particle test on each new weld.

From this station, the rail moves to a rail drill for drilling of the rail ends. A joint is then applied and the rail is propelled out of the building by the outgoing pusher through a guide system, same as the one that guided the rail into the plant. The rail moves back into the storage rack for reloading onto a rail train for shipment to another rail relay location.

The reweld plant has produced on an average of six strands of rail per day, which be slightly over 200 miles of rail per year. The plant has been operating now for over two years.

The objective, in the beginning, was to develop a facility to reduce the labor involved in the field processing of this type rail, and also reduce the number of field thermit welds needed when reusing this worn released rail. We are averaging close to six welds per strand of rail and when the cost of a weld at the reweld plant is compared with the cost of a field thermit weld, the savings per strand exceed $550 or about $30,000 per train.

Not only has the company benefited from the savings of processing this rail in a fixed plant using mechanizaton, but we now have the capability to reassign all of the rail based on the amount of wear. With this control, we're able to reuse the rail in locations that will yield the best return to the railroad. Also, the fact that the rail has been processed by removing defects, such as bad nicks, engine burns, battered rail ends and even some scrap, a much better quality rail is reassigned for reuse which will yield a longer rail life and reduce the maintenance cost.

Our objectives have been accomplished with the reweld plant. This facility is providing our company with a fixed plant to reclaim and process release welded rail using mechanization which has reduced our cost to reclaim this type rail. It is also providing us with a better quality release welded rail to upgrade our secondary main lines, sidings and yards, which was our ultimate goal.

Thank you. (Applause)

Mr. Ogden: Any questions?

Bill Autrey (Santa Fe): Did I understand that you could run a 60-foot rail and then pull a 1200-foot rail against that and weld it?

Mr. Ogden: As short as 25 feet and then we could bring a string—a piece of rail up there, say, 1420 feet against it. That's right.

Mr. Autrey: You could weld a 1400 footer against a 25 footer?

Mr. Ogden: Yes, sir.

Mr. Autrey: That's great.

Why Remove Thermit Welds

Clarence McFadden (Missouri-Pacific): Would you give me your reason for cropping out your thermit welds?

Mr. Ogden: Well, we hadn't had any problems with it except to take the thermit weld through the plant and through the classification storage rack, we would have had to come up with a method to remove the upset metal on the base. We had to do something with that. And also the thermit weld had already passed through the pusher a couple of times with this excess metal on the base. So we just thought it was best to take it out.

Mr. McFadden: I see. I thought maybe it was account of batter or something, but that batter shouldn't have been any worse than did your regular plant weld.

Mr. Ogden: No, it wasn't that. We just, like I said, we had to do something with the upset metal on the base and the fact that it had passed through that pusher twice with the pressure and then it would not go through the classification storage area without doing something to that upset metal, so we just thought it best to take it out.

Mr. Moorman: Thank you, Mr. Ogden.

At this time I'll turn the program back over to President Sutherland.

President Sutherland: Thank you, Mr. Ogden, for a very fine presentation. I'm sure there's a lot of people here today that would like to have such a facility on their property. I know we would on ours.

Now, I return the rostrum back to President Hyma.

President Hyma: To introduce our next speaker I'd like to call on Mr. Budzileni, the Junior Vice-President of the B & B Association and Chairman of our Special Features Committee. Jim.

Introduction of Next Speaker

Mr. J. Budzileni: Good morning.

This special feature is on construction of the Illinois Central Gulf Tennessee Tombigbee Waterway Bridge at Baden, Mississippi. George Krupa, Senior Staff Engineer for the Illinois Central Gulf is going to give the address.

George received his Master's Degree in Civil Engineering from Illinois Tech. He is also a registered professional engineer in the State of Illinois. George started with the ICG in 1970 and has worked his way through many positions and has held his present position since 1980.

George, are you ready?

Construction of Tenn-Tom Bridge

By GEORGE E. KRUPA

Senior Staff Engineer, Illinois Central Gulf

Thank you, Jim.

Presidents Hyma and Sutherland, Members of the Association and guests, I would also like to thank you for giving me the opportunity to talk to you this morning about the Illinois Central Gulf Railroad's bridge over the Tennessee Tombigbee Waterway at Baden, Mississippi.

May we have the first slide.

(Whereupon, there was a slide presentation with the accompanying remarks.)

For those of you who may not have heard of or are unfamiliar with the details of the Tennessee-Tombigbee Waterway, Tenn-Tom for short, let me give you some background information on the project.

The waterway was first proposed by the Spanish in 1560, and then again by the French in 1760. The United States Congress first looked at the waterway in 1810 and the Corps of Engineers made its first survey in 1827. The project was deemed economically justified in 1938 and authorized in 1946. The first money for the project was appropriated in 1967 and construction began in 1971. The project originally scheduled for completion in 1986 is currently 18 months ahead of schedule and should open in 1984.

The Tenn-Tom is a 232 mile waterway connecting the Tennessee and Tombigbee Rivers with improvements to the Tombigbee River to make it navigable. The Tombigbee River, farther downstream, combines with the Black Warrior River and is already navigable from this point until it enters the Gulf of Mexico at Mobile, Alabama.

The Waterway is divided into three sections, the divide section 40 miles long—I guess you can see that up on the top—, the canal section 44 miles long and the river section 148 miles long. It has five locks and dams. The total lift through the locks is 341 feet, with a maximum lift of 84 feet. The channel is 300-feet wide, except in the divide section where it is 280 feet wide, and the channel is 12 feet deep, except in the river section where it is nine feet deep.

G. E. Krupa

Construction of the Tenn-Tom has necessitated the relocation of eight railroad lines, the ICG twice, the Southern Railway System twice, the Burlington-Northern twice, and the Columbus and Greenville and the Mississippi Railway each once.

There will be six railroad bridges across the Tenn-Tom. The ICG, SRS and BN will each have two. These eight railroad relocations are estimated to cost $171 million in 1980 dollars.

It is an Expensive Undertaking

A total of 13 highway bridges will cross the waterway at various points along its length. The cost of the waterway is estimated at $1,790 million in federal funds and $170 million is non-federal funds, mostly state funds, for a project total of $1,960 million. These amounts are in 1980 dollars. This is a lot of the taxpayers' money to be spent on our competition by the government.

The ICG's relocation at Baden, Mississippi, which is near the north end of the

waterway, consists of several parts: a new communication system, including microwave tower; a new signal system; two bridges, including the one I'll talk about today; approximately ten miles of new track and subgrade, including a siding; and approximately one and one-half miles of temporary run-around track on a 120-foot high temporary embankment across the waterway. This embankment contained a 500-foot long, 12-foot diameter, drainage pipe.

In red is shown our relocated line. You can just make out, down here, and then right down through the waterway, itself, is where our old track was. So we kind of had them in a bind here. They couldn't build it without totally relocating us for the ten miles. You can see the little run-around track here and the bridge across the waterway.

This 12-foot diameter pipe was to carry the area's drainage for approximately four years. Keeping this pipe open to drainage was a large problem. The waterway in this area is essentially flat, providing minimal drainage and the surrounding soil is highly erodible. These conditions combined to produce a sizeable siltation problem.

The first solution was to temporarily divert the water with pumps and send men and equipment, such as front-end loaders, into the pipe to clean it out. This scheme was not very successful. Next, a small dam was built downstream and the pipe kept partially flooded. In the resulting pool, a small dredge was kept and it was sent into the pipe to keep it clean.

This was also only partially successful. And if you look down at the bottom you can see our dredge about to go into the pipe. After a while the crews refused to go in anymore. It got pretty bad in there with all the engines running.

The final solution was to build an inlet structure and settling pond to keep the silt out of the pipe. The opening of the inlet structure was adjustable by the addition or removal of metal planks. An outlet structure was also built to prevent an inflow of silt from downstream during flood conditions.

Built for E-80 Loading

The ICG's high-level bridge near Baden, Mississippi, was designed by the Clark Dietz Division of CRS Group Engineers for a Cooper E-80 loading and has a total length of 1,178 feet. It consists of ten concrete piers and two abutments supported by steel piles; ten deck-plate girder approach spans—four at 57 feet 8 inches and six at 76 feet 0 inches—these are equally divided between the two approaches; and a 465-foot 6-inch deck-truss as the main span. All spans, including the truss, are made of A-588 steel and have concrete decks.

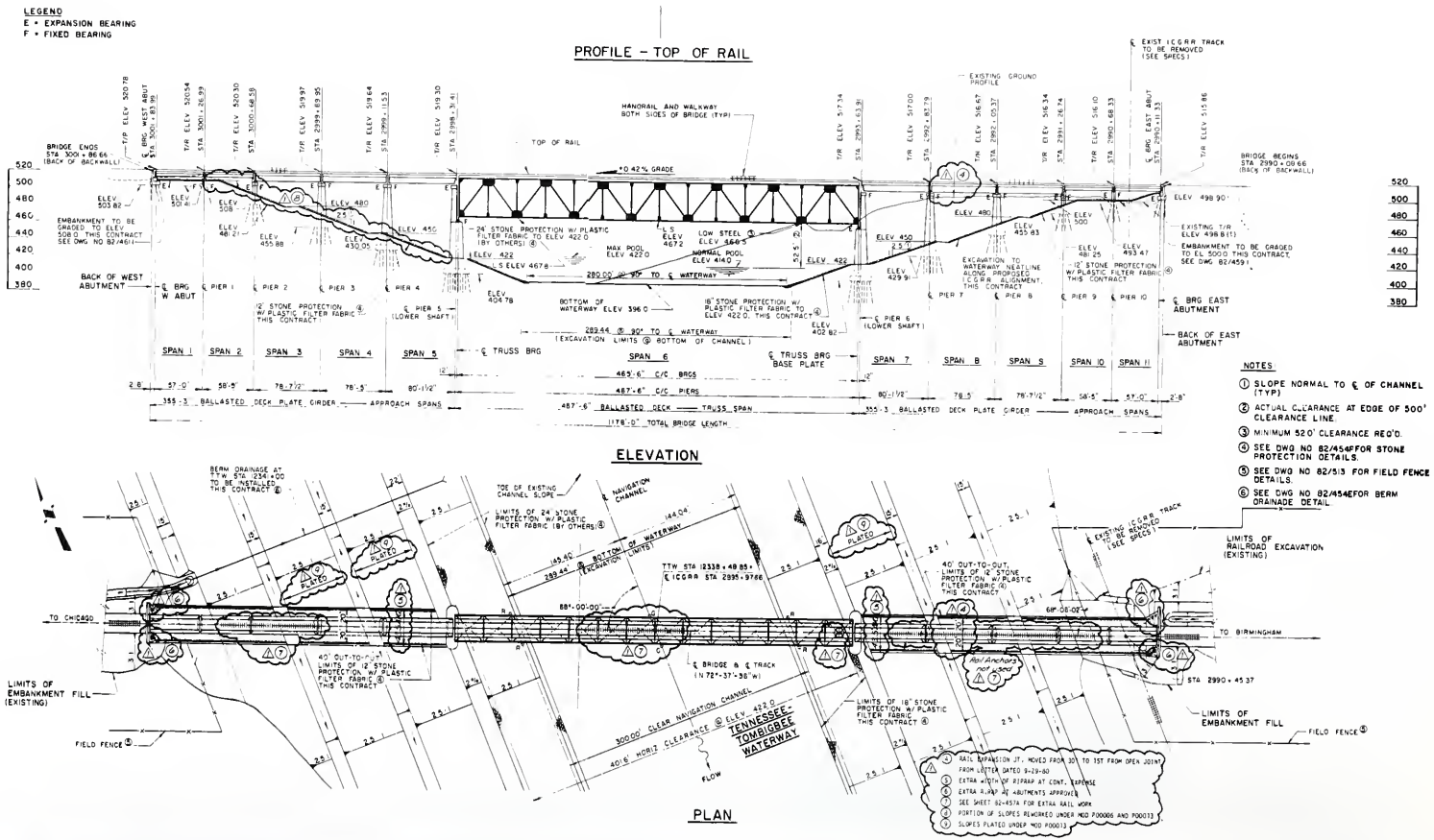
These next five slides are of the bridge's east approach and show typical construction activity. On any project of this magnitude, it is necessary to work in several areas at one time. Thus, while every pier proceeds from excavation, to piling, to footing, to shaft, to cap, you could, by moving from pier to pier, see these activities at one time. Because of the variations in pier size and to best show the particular construction activities, I will be moving from pier to pier with the slides instead of following one pier from start to finish. I trust this will not cause any confusion.

Now that the waterway and overall project background has been established, we can see what it takes to turn this virgin bridge site into a $8,932,000 railway bridge.

Peter Kiewit and Sons Company was the prime contractor, performing the work under a contract with the Corps of Engineers. The bridge is oriented in an east-west direction, and in this slide, taken at the start of construction and looking to the northeast, you can see the temporary run-around track in the background and the permanent track sub-ballast in the lower left-hand corner. Now, looking directly up the waterway, you can see its completed west bank on the left-hand side.

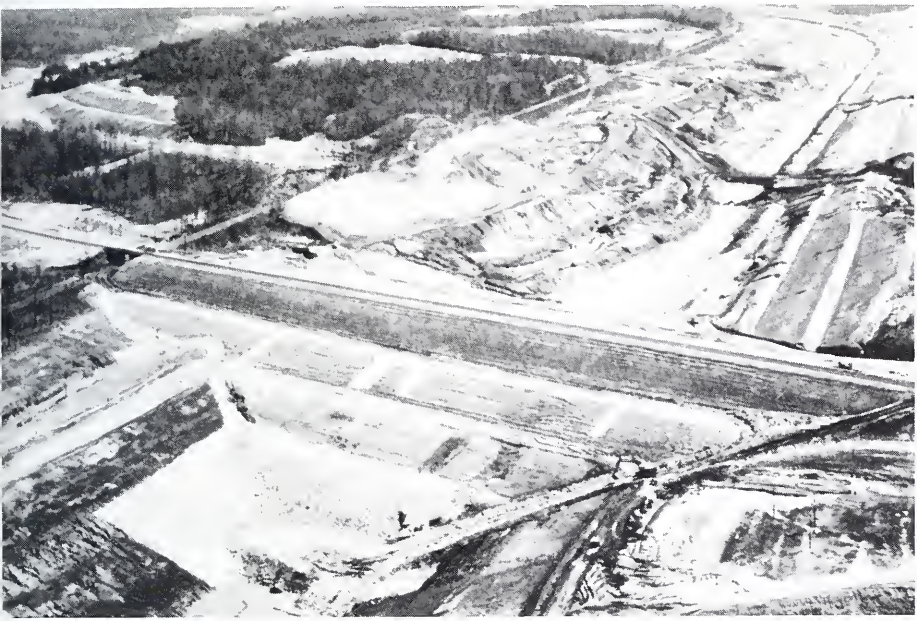
The new run-around track, approach subgrades, and waterway west bank were built under separate contracts. Kiewit's bridge contract did include the excavation of the east bank of the waterway turning it into a mirror image of the finished west bank. This was no small feat, requiring 498 thousand cubic yards of excavation. Half a million cubic yards may sound like a lot, but compared to the excavation of 90 million cubic yards on the section of waterway just north of the bridge, it was just a drop in the bucket.

Excavation at the bridge site was greatly facilitated by the borrowing of earth-moving

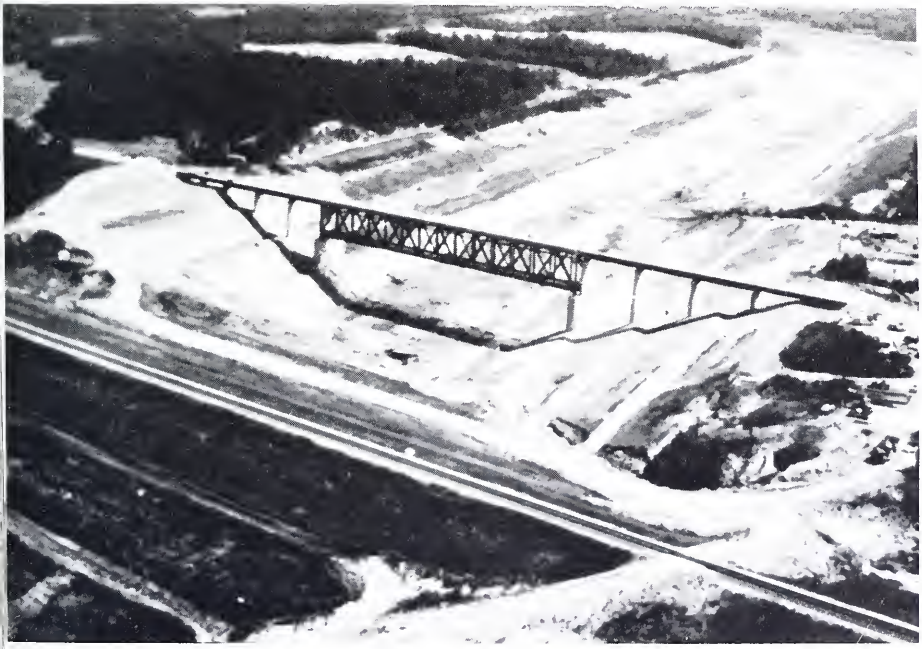

LEGEND
E = EXPANSION BEARING
F = FIXED BEARING
PROFILE - TOP OF RAIL
ELEVATION
PLAN
NOTES
1. SLOPE NORMAL TO ℄ OF CHANNEL (TYP)
2. ACTUAL CLEARANCE AT EDGE OF 300' CLEARANCE LINE.
3. MINIMUM 520' CLEARANCE REQ'D.
4. SEE DWG NO 82/454F FOR STONE PROTECTION DETAILS.
5. SEE DWG NO 82/513 FOR FIELD FENCE DETAILS.
6. SEE DWG NO 82/454E FOR BERM DRAINAGE DETAIL.
BRIDGE ENDS STA 300+86.66 (BACK OF BACKWALL)
BRIDGE BEGINS STA 2990+09.66 (BACK OF BACKWALL)
BACK OF WEST ABUTMENT
BACK OF EAST ABUTMENT
℄ BRG W ABUT
℄ BRG EAST ABUTMENT
℄ PIER 1
℄ PIER 2
℄ PIER 3
℄ PIER 4
℄ PIER 5 (LOWER SHAFT)
℄ PIER 6 (LOWER SHAFT)
℄ PIER 7
℄ PIER 8
℄ PIER 9
℄ PIER 10
SPAN 1
SPAN 2
SPAN 3
SPAN 4
SPAN 5
SPAN 6
SPAN 7
SPAN 8
SPAN 9
SPAN 10
SPAN 11
℄ TRUSS BRG
℄ TRUSS BRG BASE PLATE
469'-6" C/C BRGS
487'-6" C/C PIERS
487'-6" BALLASTED DECK TRUSS SPAN
1178'-0" TOTAL BRIDGE LENGTH
355'-3" BALLASTED DECK PLATE GIRDER — APPROACH SPANS
EXISTING GROUND PROFILE
HANDRAIL AND WALKWAY BOTH SIDES OF BRIDGE (TYP)
TOP OF RAIL
+0.42% GRADE
24" STONE PROTECTION W/ PLASTIC FILTER FABRIC TO ELEV 422.0 (BY OTHERS) ④
12" STONE PROTECTION W/ PLASTIC FILTER FABRIC ④ THIS CONTRACT
18" STONE PROTECTION W/ PLASTIC FILTER FABRIC TO ELEV 422.0, THIS CONTRACT ④
EMBANKMENT TO BE GRADED TO ELEV 508.0 THIS CONTRACT SEE DWG NO 82/461
EXCAVATION TO WATERWAY NEATLINE ALONG PROPOSED I.C.G.R.R. ALIGNMENT, THIS CONTRACT
EMBANKMENT TO BE GRADED TO EL 500.0 THIS CONTRACT, SEE DWG. 82/459 ④
EXIST I.C.G.R.R. TRACK TO BE REMOVED (SEE SPECS.)
EXISTING T/R ELEV 498.8 (T)
L.S. ELEV 467.2
LOW STEEL ③ ELEV 460.5
NORMAL POOL ELEV 440.0
MAX POOL ELEV 422.0
BOTTOM OF WATERWAY ELEV 396.0
289.44 ⓒ 90° TO ℄ WATERWAY
(EXCAVATION LIMITS ⓒ BOTTOM OF CHANNEL)
289.44 ⓒ 90° TO ℄ WATERWAY
BERM DRAINAGE AT T.W. STA 2336+00 TO BE INSTALLED THIS CONTRACT ⑥
TOE OF EXISTING CHANNEL SLOPE
LIMITS OF 24" STONE PROTECTION W/ PLASTIC FILTER FABRIC (BY OTHERS) ④
℄ NAVIGATION CHANNEL
144.04
142.40
BOTTOM OF WATERWAY EXCAVATION LIMITS
TTW STA 12338+49.85 ℄ ICGRR STA 2995+97.66
88°-00'-00"
68°-08'-02"
40' OUT-TO-OUT LIMITS OF 12" STONE PROTECTION W/ PLASTIC FILTER FABRIC ④ THIS CONTRACT
40' OUT-TO-OUT LIMITS OF 12" STONE PROTECTION W/ PLASTIC FILTER FABRIC ④ THIS CONTRACT
PLATED
Rail Anchors not shown
℄ BRIDGE & ℄ TRACK (N 72°-37'-36" W)
300.00' CLEAR NAVIGATION CHANNEL @ ELEV 422.0
401' HORIZ. CLEARANCE @ ELEV 422.0
TENNESSEE-TOMBIGBEE WATERWAY
FLOW
LIMITS OF 18" STONE PROTECTION W/ PLASTIC FILTER FABRIC THIS CONTRACT ④
LIMITS OF EMBANKMENT FILL (EXISTING)
LIMITS OF RAILROAD EXCAVATION (EXISTING)
LIMITS OF EMBANKMENT FILL
FIELD FENCE ⑤
TO CHICAGO
TO BIRMINGHAM
STA 2990+45.37
② RAIL EXPANSION JT. MOVED FROM 30' TO 15' FROM OPEN JOINT FROM LETTER DATED 9-29-80
③ EXTRA WIDTH OF RIPRAP AT CONT. EXPENSE
④ EXTRA RIPRAP AT ABUTMENTS APPROACH
⑤ SEE SHEET 82-457A FOR EXTRA RAIL WORK
⑥ PORTION OF SLOPES REWORKED UNDER MOD P00006 AND P00013
⑦ SLOPES PLATED UNDER MOD P00013

50

Profile of Bridge



Bridge site from the air at start of construction looking southeast.



Bridge site from the air at the end of construction looking southeast.

equipment, such as backhoes, scrapers and dozers from another Kiewit sub-group, which was constructing the six miles of waterway immediately south of the bridge.

Excavation Work

Excavation for the abutments and piers well up the waterway slope was done in the dry with only occasional problems from rain.

Here you can see evidence of standing water from a recent rain and several areas of erosion on the existing slope. The highly erodable soil was in action again.

The excavation for the lower footings, the lowest of which is almost 100 feet below those of the abutments was a different matter. These sites were continually wet and on occasion were totally inundated.

To promote drainage, the sites were over-excavated, back filled with granular material and sumps placed to pump away the water.

This is a typical site, with sand under the footing and a perimeter of crushed stone to intercept the water. Only 50 percent of the footings could be excavated using open cuts, the other six had to have retaining walls or a cofferdam. These were all constructed of steel sheet piles, driven for the most part by a diesel hammer. A vibratory hammer was tried but had very little success due to the type of soil at the site.

The first structure built was a cofferdam for one of the deeper footings on the west slope, as this minimized the disturbance of the finished slope.

The other five structures, of which two can be seen here on the right-hand side, consisted of cantilevered sheet-pile walls in the shape of a "U."

Excavation inside these walls was done with a backhoe and final grading done by a small dozer. Although the vibratory hammer was unable to drive the sheet piles, it was very useful in their removal as can be seen here.

Test Piles are Driven

The first phase of permanent construction was the driving and loading of test piles. These test piles were to be the means of determining the order lengths of the permanent bearing piles.

The test pile was driven and four reaction piles were driven around it. These reaction piles, along with cables, a girder, and two braces, became a test stand. A hydraulic jack and measuring device completed the test apparatus. The test piles were loaded at a specified rate until they were carrying 130 tons, approximately twice its service load. This was held for 24 hours and then unloaded at a specified rate.

Throughout the test measurements of pile settlement were taken to record settlement during loading, settlement during sustained load, and rebound during unloading. Test success was based on total settlement and rate of settlement. Because the entire test takes 30 to 37 hours, a tent was placed over the test stand to minimize the effect of temperature variations between day and night.

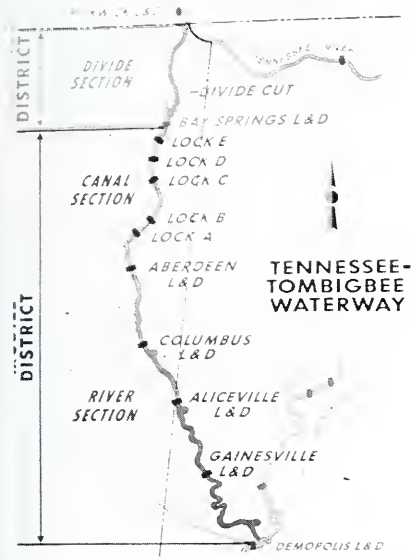
A different version of the test stand can be seen here with the cables and braces replaced by longer reaction piles and cross beams. While the specifications called for a test pile at every pier, this was waived after the first several tests, because the results correlated extremely well with the soil consultant's predictions.

After the bearing piles of proper length had arrived, the pile pattern was laid out and driving begun. The bearing piles, all HP 12 by 53's were driven by a Vulcan No. 2 single-acting hammer, powered by an air compressor. Seven hundred forty-three piles were driven for a total of approximately 12,000 linear feet of piling on this project.

After driving, the piles were cut off with an oxy-acetylene torch. The pile butts became the property of the contractor for removal from the bridge site. Cut-off elevation was kept slightly above that called for on the plans. This was done so that even in case of an error there would be sufficient pile embedment in the footings.

Reinforcing Steel Placed

With pile-driving complete, pier construction began with the foundations. Usually reinforcing steel was placed first, but occasionally forms were built simultaneously or even first. The placing of rebars first im-



Map of the Tennessee-Tombigbee Waterway.

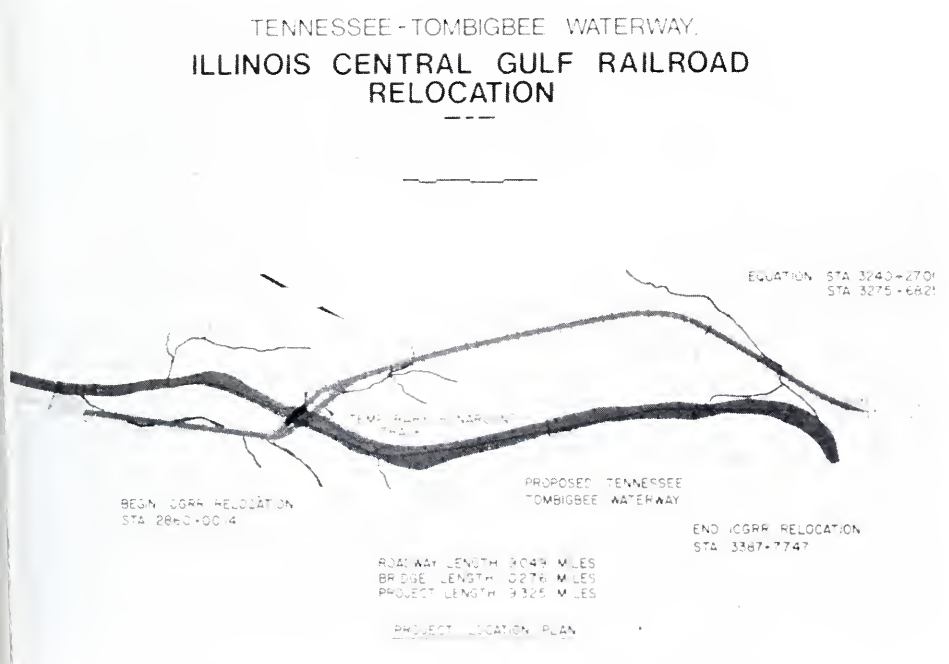
proved the productivity of the iron workers as they had much better access to their work.

When tying steel, every intersection of a grid was tied if the grid was vertical, such as the side of a foundation or a pier shaft. But in the case of a horizontal grid or mat only every other intersection was tied.

Footing forms were generally braced both internally and externally. In addition to snap ties, struts were placed to stakes in the ground, the sides of an excavation or to a deadman.

This slide shows struts that were placed to a pile laid horizontally on several deadmen. These deadmen consist of a cube of concrete four feet on a side with a four to six-foot piece of pile embedded three feet in it. These were constructed on the site and, weighing approximately 9,600 pounds each, were very useful to brace to, guy from or tie off to. You may have noticed them in some of the earlier slides and will see them periodically in the later ones.

Pouring the concrete for the footings was generally done with a bucket. Concrete



Detailed location plan of ICG RR Relocation.

mixer trucks were brought as close as possible to a pier and a strategically placed crane used to swing the buckets. One crew did all the pouring and finishing. They worked on both the bridge and the waterway south of the bridge.

To facilitate curing, a curing compound was sprayed on the finished concrete and or burleen was spread over it. Burleen is a burlap with a plastic coating on one side. Here is a typical foundation after the forms have been stripped. Pier footing concrete amounted to approximately 1,550 cubic yards.

Above the footings the pier construction technique used depended on the size of a particular pier. Small piers were built in one pour. This case of rebars includes both the shaft and cap of one of the smallest piers.

Metal Forms are Used

The total amount of concrete used in this pier was only 51 cubic yards. Metal forms were used in all pier pours above the footings. The cylindrical end-forms were custom-made for this job, while the straight-side forms were stock items. Please note the deadmen being used to anchor guy wires from the forms.

A large pier, the footing for one which you can see here, would have multiple pours for its shaft and a separate pour for its cap.

The rebars for one pour would be assembled off to one side. Here you can see two straight grids for the straight side of a pier, and if you look carefully, you can make out two half-cylinder grids on the top of these for the round trip pier ends. Right in here.

These pre-tied grids were set in place by a crane, tied to each other and the dowels projecting up from the footings. The metal forms were set by crane then bolted together. These forms were internally braced using steel rods approximately one inch in diameter.

These rods had detachable ends which were screwed off after the forms were removed, leaving only a small hole to be patched by the finishers.

Tremies were placed in the forms to chute the concrete from the top of the forms and avoid segregation. Concrete was delivered by truck from local ready-mix plants and placed by bucket.

This is a completed first shaft pour with reinforcing steel in place for the second pour.

Special Brackets Support Forms

To support the forms for the upper section of the pier shaft, special brackets were attached to the top row of internal braces from the last pour. A new rebar cage was placed and the next lift of forms set. The system of internal bracing, tremies and pouring by bucket was repeated. Some tall piers required four or even five lifts. This is one of the largest piers; it required five shaft pours and a cap pour. It contains a total of 2,169 cubic yards of concrete.

The last type of substructure concrete pour was for the caps. For these pours the rebars were pre-assembled and set in place as a unit after the forms were placed.

Steel forms were used again, but a walkway was built around them to give the finishers a place to stand while applying a steel trowel finish to the concrete surface. Anchor bolts on this project were cast in place. They were tied to a wooden framework on top of the cap forms to hold them in place until the concrete was set up.

On top of the closer cap, wrapped in black plastic, is a small pedestal. This pedestal was to make up the difference in depth between the 57 foot 8 inch and 76 foot 0 inch approach spans. The black plastic was to facilitate curing. This is one right here.

Because of their differences, particularly above the foundations, I have left the abutments out of the discussion of the piers. Abutment rebars were all tied in place, with the work being done ahead of or concurrently with the construction of the forms.

Form work was all custom made at the site by Kiewit's carpenter gang, and used a combination of internal and external braces. Two pours were made above the footings; first, the bearing area and the bottom portion of the back wall and wing walls; and, second, the upper portion of the back wall and wing walls.

After form removal, the exposed areas of the abutments were finished. The back of the back wall and wing walls, although not fin-

ished, had fins removed and holes patched. This area was then coated with an asphalt damp-proofing compound. A perforated pipe was placed behind the abutment and the area backfilled with granular material to promote drainage.

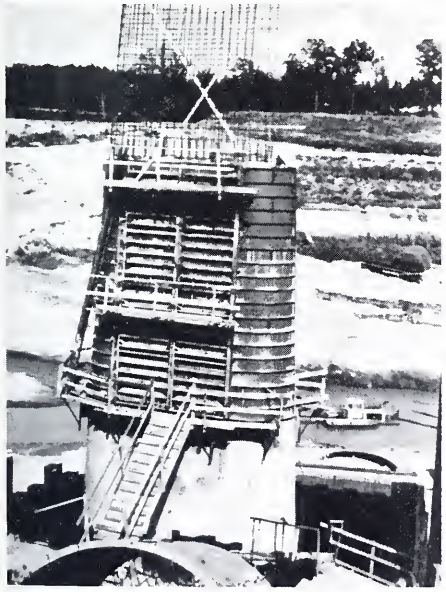
Concrete Obtained from Ready-mix Plant

Concrete for all applications amounted to approximately 7,850 cubic yards and was made with Type II Portland cement. It had a 28-day strength of 3,500 pounds per square inch. This was all purchased from two local ready-mix plants that were located approximately ten miles from the site and delivered to the site by mixer truck, occasionally through some fairly wet conditions. Except for the span deck concrete, which was mostly placed by conveyor, all concrete was placed by crane and bucket.

Individual pours ranged in size from 21 cubic yards to 480 cubic yards. This large pour took 12 hours for a pouring rate of 40 cubic yards an hour. This rate, although not particularly high, was the best the ready-mix plant could do based on the distance the concrete had to come and the number of trucks they had available.

Quality control was the responsibility of the contractor. Slump and air tests were run under the supervision of the Corps. Slump limits were two to four inches and air limits were three to six percent. Concrete cylinders made for each pour were temporarily stored in the curing box, visible in the background, before being moved to the Corps' lab to finish curing and be tested.

Exposed sub-structure concrete, except for the bearing areas, was given a Class 2 finish. This consists of rubbing the concrete with a medium coarse carborundum stone using a cement and fine sand mortar, until a uniform surface has been obtained. After the mortar had dried the surface was rubbed with burlap to remove loose powder. After finishing, the concrete was sprayed with a silicon water repellent.



Pier under construction looking northeast.

Steps to Prevent Staining

Immediately prior to the setting of the steel spans, the pier tops were wrapped in plastic. Spans for this bridge were made of A-588 steel, also known as weathering steel. This steel corrodes for only the first several years, forming a permanent oxide layer, which prevents further rusting. During this initial period of oxidation, the steel will stain the concrete. In an attempt to prevent this staining, the finished pier tops were wrapped in plastic.

Now, before you run out and start wrapping any of your own piers, let me tell you that it didn't work. The plastic deteriorated in a very short time. In later slides you'll see stains on the piers before the bridge is even finished.

Backfilling around the piers used various pieces of equipment. The large open-cut excavations were backfilled using scrapers and large dozers to place the fill, and dozers with vibratory rollers to compact it in four-inch lifts. As the work area got smaller, dozers did all of the placing with a compactor consolidating the fill. In the tightest areas, a Bob Cat was used to place the fill and a walk behind compactor used to compact it.

If you look carefully, you can see that the operator is female. She was one of several women that worked on the bridge.

Inside the cofferdam, the fill was dumped by front-end loader, placed by hand and compacted by small vibratory compactors. Here is a typical pier after backfilling was completed.

The structural steel for this project, totalling approximately 2,395 tons, was fabricated by Vincennes Steel and erected by Bristol Steel Erectors. The approach girders were delivered to the site by truck and set in place on their shoes by crane. Until the bracing was installed between the girders, they were held in place by cables.

The lateral metal works on top of the girders at their ends are expansion dams. These confined the concrete decks while they were being poured and provided a base for the expansion plates which span the gaps between the pairs of girders.

Erection of the trusses began at the west end with the setting of their bearings. During erection the trusses were supported at the quarter points by falsework.

Two Sets of Falsework are Used

Although there were three support points, only two sets of falsework were used. The set at the first quarter point was moved to the third quarter point after erection reached the one-half point.

The falsework at the one-half point was supported by steel piles temporarily driven into the waterway channel. The falsework which was moved between the quarter points was supported by a spread footing. The falsework consisted of a steel framework and hydraulic jacks. These jacks were used to adjust the elevation of the falsework, setting the falsework's initial elevation and later allowing the falsework to be removed.

As construction progressed, safety nets were strung and the bridge's access ladder and walkway system were erected. Fortunately, the safety nets had to catch only a couple of dropped hard hats and empty bolt keys.

Truss Erection Done Simultaneously

Erection of both trusses proceeded simultaneously, with one truss never getting more than a couple of members ahead of its counterpart.

Concurrent with truss erection was the erection of the trusses' bracing system. This helped in truss alignment and provided necessary lateral support.

Floor beam erection followed truss erection by approximately four panels. The south truss was the first to reach the east side, and here you can see the southeast shoe being swung into place.

With some minor adjustments to both the shoe and the truss, the bottom chord was completed. Everyone involved breathed a sigh of relief, for although the bridge was laid out using electronic surveying equipment, one still wondered about the span not fitting.

During final inspection it was discovered that the anchor bolts had been laid out improperly. They were two inches too close together. This was corrected by jacking up the truss, slotting the holes in the base of the expansion shoe, and sliding the base over two inches. After the truss was set back down, the slotted holes were filled with lead to insure there would be no movement.

The making of an individual truss connection began with fit up. The members were brought into alignment and enough bolts and pins placed to secure the connection, usually a third to a half of the holes were filled. At this point the erection crews were finished and they went on to other members and connections.

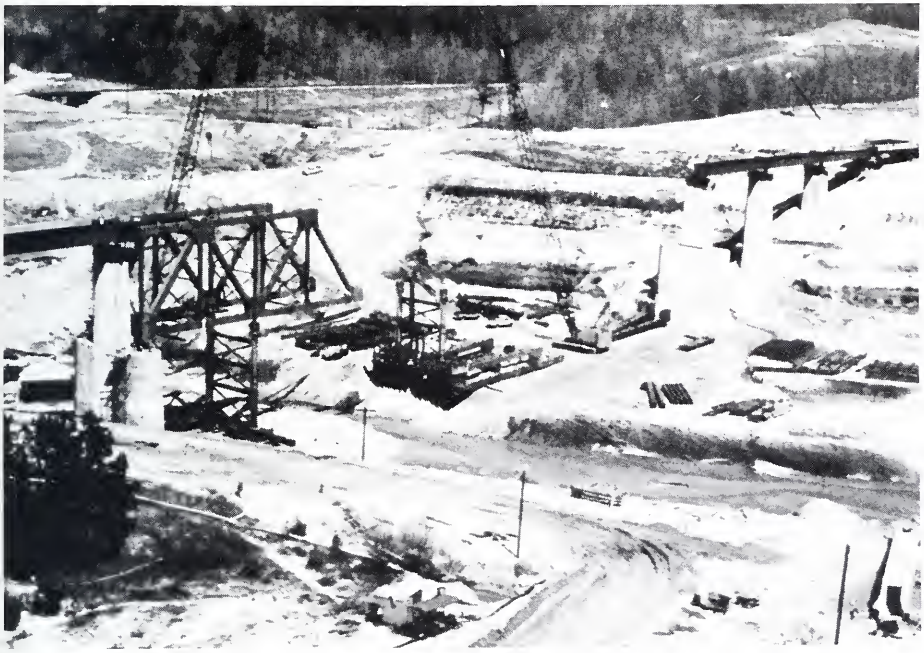
The bolting crews then took over and more bolts and pins were added until every hole was filled.

Finally, the pins were replaced by bolts and the entire connection tightened by the turn-of-the-nut method.

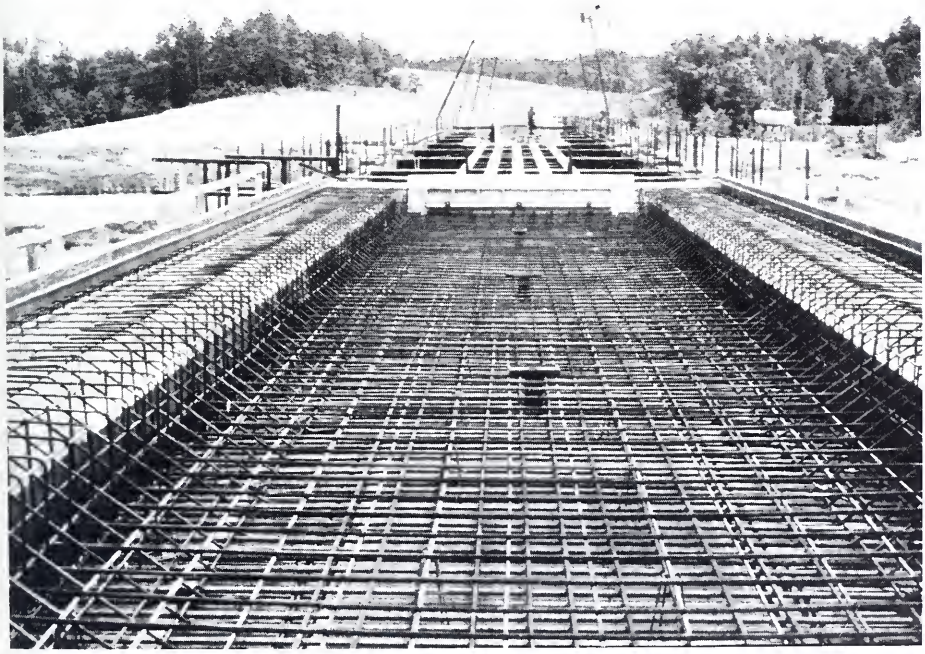
The bolting crews worked on scaffolding. This scaffolding consisted of a four-foot by four-foot piece of plywood hung from the truss with ropes. The erection crews finished well ahead of the bolting crews and then assisted the bolting crews in completing the job.

Build Two Inspection Walkways

The 44-foot 6-inch depth of the truss makes it necessary to have two levels of walkway. One is immediately below the floor system—which runs right down in here—to facilitate its inspection; and a



Truss under construction from the air looking northeast.



Bridge deck under construction looking east.

second is at the level of the bottom chord for inspection and access to the navigation lights. The platform on the right is where a navigation light will be installed.

The walkways consist of galvanized bar gratings supported by channels, with steel handrail posts and galvanized cable as handrails. In the upper portion of this slide you can get an idea of the maze of truss bracing erected.

The floor system is a conventional floor beam and stringer system. Most of the stringer to floor beam connections are ordinary bolted connections; however, at two equally spaced locations, the stringers rest on brackets attached to the floor beams. These special connections allow for expansion and contraction of the truss floor system.

This is a typical stringer-floor beam arrangement. It is shown to illustrate the matchmark system employed. In addition to the painted members and letters, you can see a series of circles. Within these circles were punched the matchmarks. This insured that had the paint been removed the matchmarks would have survived.

This is the completed truss.

Spans Have Concrete Decks

All the spans have poured-in-place concrete decks. Building the forms for these decks was one of the most intricate jobs on the bridge. The ballast troughs were 12 feet wide and one-foot three-inches deep, with a four-foot nine-inch walkway cantilevered off each side.

For the approach spans, joists were placed between the girders and out from each side. The wires, right in here, crossing the top flange of the girders' supported beams on which the joists rests. The ends of the joists away from the girders were, again, supported by a beam. However, this beam was supported by diagonal struts resting on the top of the bottom flange. These struts were held in place by rods attached to the top flange via small brackets. These brackets were left in place, but the rods removed with the forms. Here are the rods and brackets.

Additional wood framing and plywood facing completed the forms. Besides supporting the forms, the joists also supported narrow walkways with timber handrails. Please note the black pipe protruding through the forms. This is part of the span's drainage system.

Here is a completed approach span form in the process of receiving concrete. Looking at the pier on the left you can see the plastic wrap is gone and the pier is already stained by the weathering steel.

On the truss, the joists were supported by timber posts and frames at the stringers and by brackets at the top chord of the truss.

Reinforcing steel was then placed in both the trough and walkways. A series of metal beams across the tops of the forms held the forms together and supported the curb forms. These are the curb forms, right through there.

Except for the end spans the concrete was placed by conveyor. Mixer trucks were backed onto the adjacent span and the concrete chuted onto the conveyor, which then transported it to the desired location in the forms. Once in the forms, the concrete was consolidated using vibrators and given a brushed finish.

Here is the completed deck awaiting cleaning and waterproofing. Please note the notch in the curb to accommodate membrane water-proofing and its protective course. That's right here.

Each walkway has a galvanized steel pipe handrail. This handrail is attached to the concrete deck by cast-in-place anchor bolts.

The deck is sloped to drain to these periodic drain holes. After cleaning, this one received a grating to cover it. The drain holes lead to a pipe under the deck. These pipes carry the water to the bottom of the span where it falls to the ground below. The undersides of the deck received a Class I finish. This consisted of the removal of fins and the filling of holes.

Truss Cleaned by Water Jet

After the truss deck was poured, the truss was cleaned using a high-pressure water jet. Tank truck and pump were driven on to the truss and the truss sprayed.

In addition to removing concrete splatter from the truss, the spray was able to remove the painted matchmarks. By looking closely at the end of the floor beam you can see

Completed truss looking northwest.

where these matchmarks have been removed by the water jet. This practice gives a better looking bridge. Painted matchmarks are known to remain in place years after they should have disappeared.

Decks are Waterproofed

Following truss cleaning, the concrete decks were cleaned and waterproofing begun after the decks dried.

The first phase of waterproofing was to take care of the expansion joints. The area next to the one-half inch thick expansion plate which spans the gap between the girders was lined with anti-bonding paper and filled with a polysulfide joint sealing compound. The joint was then covered by a 22-gauge sheet of galvanized iron, 18 inches wide, and then by a three-foot wide sheet of butyl rubber which was glued to the concrete. Next, the waterproofing membrane was applied to the entire deck.

A sheet of 3/32nd-inch butyl rubber was used as the waterproofing membrane. It was applied from full-width rolls with only occasional transverse joints. At the abutments the membrane was carried down the back walls, but no protective course applied.

The protective course consisted of three layers of asphalt panels providing a total thickness of one and one-quarter inches. The joints were staggered between the layers and the joints of the top layer were sealed with an asphaltic cement.

Here is a typical section of finished deck, including the deck drain with grating.

From the bottom of the waterway to the first bench on its side slopes, a vertical distance of approximately 25 feet, the waterway slopes are protected with riprap.

In addition to this, at the bridge site a 40-foot wide band of riprap was carried up to the abutments.

Under the riprap is a layer of filter fabric. This filter fabric was placed by hand and secured by pins until the riprap was placed.

The riprap was man-sized with the largest pieces weighing 125 pounds. It was initially placed using a crane and orange peel and some moving by hand was necessary to provide uniform coverage.

This completes my discussion of how to turn this bridge site into a high-level railroad bridge.

Now, before I answer any questions you may have, allow me to show you five rather artistic photographs of the completed structure.

(Whereupon, the photographs were shown.)

In this one you can see the temporary run-around track is being removed over on the right-hand side.

Now, are there any questions?

Use of Waterway

From the floor: What type of marine vessel will be using the waterway?

Mr. Krupa: It will be a conventional towboat and barges.

From the floor: Twenty-five feet?

Mr. Krupa: That 25 feet is the wave zone. The depth is nine or 12 feet, depending on which way—which part of the waterway you are in. The width is 280 or 300 feet wide.

From the floor: What is the vertical clearance?

Mr. Krupa: Vertical clearance is about 55 feet from normal pool. It's 110 feet from track level down to normal pool.

Arvie Maynard (Chessie System): It's not a question, but maybe a comment. I think that's a tremendous engineering feat. I recently wrote my representative in West Virginia concerned about just enlarging a little bit of a gap in bridge, lock and dam and who was going to pay for it. I've been asleep about what's been happening with my income taxes. I hope that everyone in here realizes that we are a free enterprise system and we are out here trying to get business through our work and the free enterprise system. It appalls me to think that my company pays me a wage and the government takes half of it away and I can't see where it's building a tax service. Now it might be that I might be blind to the justification that sharp pencils of the Corps of Engineers could put on to justify that. Now, it's just appalling to me the type of competition that we're up against the railroad industry, and I hope that we all write our Representatives and Congressmen urging that they and President Reagan get across to this country that user charges must be applied to financing some of this stuff. It's going to be a big toll to pay for that. (Applause)

Mr. Krupa: Are there any other questions? (No response)

Mr. Krupa: Well, President Hyma and Jim, thank you very much.

President Hyma: Well, thank you, Jim and George. That's a very impressive project and we are indebted to you and the ICG for your presentation; and the comments from the floor, obviously, needed to be said, and we really need to take this to heart.

Gentlemen, this concludes our opening session, and I want to congratulate all of our speakers for bringing us in on time. In fact, we're five minutes ahead of time, which is rather remarkable.

Now, there are no scheduled sessions this afternoon so that you'll all have time to attend the equipment show. You are reminded that the REMSA banquet is tonight at 6:30. The ladies' presentation is in the hotel at 2:00 o'clock this afternoon.

We will reconvene again in joint session tomorrow morning in this same room and, again, at 8:30.

One other comment, any of you who were unable to register before coming up to these sessions, the registration desk will be open this afternoon. You will need your registration to get into the equipment show, so if you have not already registered, please do so.

President Sutherland, do you have anything else to add at this time?

President Sutherland: Just one comment, President Hyma. For the benefit of the ladies, we have 464 registered.

(Whereupon, the proceedings were recessed at approximately 11:25 o'clock a.m.)

WEDNESDAY MORNING

October 6, 1982

President Sutherland: Gentlemen, please take your seats. We have an update on our registration figures, if you'd like to make a note: Railroad members, 583, associates, 669; guests, 456; a total of 1708. We also have ladies, 502, a total of 2210.

Ladies and gentlemen, members and guests, on behalf of the Bridge and Building and Roadmasters' Associations, I would like to welcome you to the Second Joint Session of this conference.

At this time, I would like to thank REMSA for the wonderful banquet and entertainment last night, and I'm sure it was enjoyed by all. Thanks, again, REMSA, for your continued support of our organizations.

As the first order of business, I would like to introduce the officers and directors of the Roadmasters' Association. Will the gentlemen please stand, and remain standing until all have been introduced. And will you please withhold your applause until all have been introduced.

Beginning at my extreme right, Mr. C. M. Funk, Director, Engineer Track, Union Pacific, Omaha, Nebraska; Mr. R. E. Snyder, Director, Director of Maintenance Operations, C&NW, Chicago, Illinois; Mr. M. J. Marlow, Director, Supervising Engineer, Track and Properties, EJ&E, Joliet, Illinois; Mr. C. W. Moorman, Director, Division Engineer, Southern, Raleigh, North Carolina; Mr. Huburt V. Meek, Director, General Roadmaster, Denver and Rio Grande; Mr. D. E. Staplin, Director, Director of Planning and Reporting, Family Lines, Jacksonville, Florida; Mr. M. B. Mitchell, Treasurer, Division Engineer, Southern, Andover, Virginia; Mr. R. V. Hernandez, First Vice-President, Track Production Manager, Southern Pacific; Mr. H. G. Webb, Director, Assistant Chief Engineer, Santa Fe, Chicago, Illinois.

You may now applaud. (Applause)

I now return the rostrum to President Hyma.

President Hyma: Thank you, President Sutherland. Several members of our Executive Board are busy with other tasks this morning, but I will introduce those present at the head table.

First, however, I want you to meet the one person who's indispensable to the operation of both the Roadmasters and the B & B Associations, and that is our Secretary, Mrs. Pat Weissmann. (Applause)

Our officers come and go but our Secretary runs the office and provides the continuity that must be maintained from year to year.

Pat, we really do appreciate the work you're doing.

Now, at my extreme left, H. J. Laga, Assistant Environmental Engineer, Chicago & Northwestern, Chicago; Director O. D. Anthony, Assistant Chief Engineer, Bridges and Structures, Bangor & Aroostook, Bangor, Maine; Director J. N. Michel, Assistant Chief Engineer, Design, Amtrak, Washington, D.C.; Junior Vice-President, J. M. Williams, B & B Supervisor, EJ&E, Gary, Indiana; Junior Vice-President, J. Budzileni, Senior Structural Designer, Illinois Central Gulf, Chicago; and our Senior Vice-President, O. C. Denz, Supervisor Building Maintenance, Milwaukee Road, Chicago; and, finally, Mr. W. C. Sturm, Senior Project Engineer, Elgin Joliet & Eastern Railway, Joliet. Wally serves as the Hotel Arrangements Chairman and takes the responsibility for the countless details involved in staging this conference. Wally is also a Past President of the B & B Association.

You may now give these gentlemen the round of applause they deserve. (Applause)

President Sutherland: Thanks, President Hyma.

At this time, I will excuse all the officers from the head table, other than those making introductions, as we will be having some slide presentations.

Introduction of J. D. Jardine

It is a pleasure to be assigned the pleasant task of introducing the next keynote speaker at this session of our Association's 94th Annual Meeting. Mr. R. R. Morrish, Chief Engineer, CP Rail, could not be here today; however, the gentleman who will speak to us today is no stranger on most Canadian and United States railways.

Our speaker, a native of Montreal, Canada, is a 1950 graduate of McGill University with a Bachelor of Engineer Degree in Civil Engineering. He also completed a Management Training Course, University of Western Ontario, 1980, and has been employed by Canadian Pacific since 1950 in various engineering capacities, including Division Engineer, Regional Engineer, Engineer of Track System, and is presently Assistant Chief Engineer. He has been a member of AREA since 1953, is a Member of Committee 5 on Track and Committee 10 on Concrete Ties and was elected a Director in 1981 for a three-year term.

Ladies and gentlemen, I am pleased to present Mr. J. D. "Jim" Jardine, Assistant Chief Engineer, CP Rail. Mr. Jardine. (Applause)

Changes in M/W Methods on CP Rail

By J. D. JARDINE

Assistant Chief Engineer, CP Rail

Mr. Chairman, ladies and gentlemen, thank you, Mr. Sutherland for the kind invitation to address the annual conference of your Association.

Prior to dealing with the subject on changes of maintenance of way methods on CP Rail, I thought it would be of interest to first tell you a little bit about Canadian Pacific. I thought it would be particularly appropriate since your President has now close to 40 years of service with CP Rail.

Could I have the lights, please?

(Whereupon, there was a slide presentation with the accompanying remarks.)

Canadian Pacific started as a company charged with building a transcontinental railway from eastern Canada to the Pacific coast over 100 years ago. From that railway evolved our present diversified company with more than $16 billion worth of assets in land, sea and air transportation, telecommunications, natural resources, hotels, real estate, insurance and manufacturing.

This particular slide shows the driving of the last spike marking the completion of the Transcontinental Railway at Craigellachie, British Columbia, on November the 7th, 1885.

J. D. Jardine

Canadian Pacific's transportation and hotel operations are linked by a common set of internationally recognized names; C. P.

ail, C. P. Air, C. P. Ships, C. P. Express & ransport, C. P. Hotels, unified by a visual ymbol called the "Multimark."

CP Rail operates 15,800 miles of main ack, extending from the Atlantic Provnces to the Pacific Coast. Its equipment ncludes more than 66,900 revenue freight ars, 1300 diesel locomotives, and 4400 units f work equipment. Canadian Pacific, imited also controls another 4400 miles of ack in the United States.

Has Many Subsidiaries

Traffic handled by CP Rail last year exeeded 61.4 billion revenue ton miles of eight. Our airline company, CP Air, is one f the world's major air carriers, having approximately 62,800 route miles, linking five ontinents and major cities across Canada. P Ships was begun at the end of the 19th entury to provide passenger and freight usiness for the new railway. Today Canaian Pacific Steamships participates in a oordinated container shipping services hich provides regular service between Montreal and ports in northwest Europe. anadian Pacific Bermuda, Limited operates or has under construction a fleet of 34 ankers and dry-bulk carriers. Canadian acific Express and Transport has a fleet of lmost 6,000 units of modern road equipent. CP Telecommunications began with he railway in the 1880's with Morse keys nd stations along the new railway line. oday, in equal partnership with Canadian ational Railways under the name CN-CP elecommunications, it supplies data transission services to business, industry and overnment across Canada. CP Hotels wns, manages and leases 22 hotels and otor hotels plus restaurants and airline atering facilities in Canada, United States, Vest Germany, Israel and Mexico.

This particular slide shows the Banff prings Hotel, located about 80 miles of algary, Alberta.

Commenco, in which Canadian Pacific nterprises has a 54 percent interest, is the orld's largest mine producer of zinc and ad, accounting for approximately nine perent and ten percent, respectively, of mined nc and lead production in the western orld.

In 1974 Canadian Pacific Enterprises purchased controlling interest in the Algoma Steel Corporation at Sault St. Marie, Ontario. It may be mentioned in passing that CP Rail purchases most of its new rail from Algoma.

Restore the lights, please.

In short, Canadian Pacific, Canada's largest company, is also one of the world's largest and most highly diversified corporations. Now, that I've told you about Canadian Pacific and some of its activities, we can perchance get down to business and to the issues at hand.

Maintenance Must Meet Traffic Needs

Maintenance-of-way work, and in particular, methods of maintaining track, not only will change in the future but must change if we are to meet the needs of traffic growth projections. To perhaps indicate what has occurred in the immediate past and what we can expect in the future, let us look at traffic levels on CP Rail's single track main line through British Columbia.

In 1965 we were handling 22 million gross tons annually. In 1981 we handled 57.4 million gross tons. Traffic forecasts now are predicting some 79.5 million gross tons will be handled by 1987. Traffic levels, such as are being indicated, will require additional track maintenance which can seriously affect line capacity.

Line capacity is difficult to define in a precise manner as many factors can affect it; thus, one has to look at each individual section of line in order to obtain an accurate capacity figure of trains per day. But to get back to the subject at hand, it's quite apparent that if we were to handle these higher levels of traffic, we must have the most efficient plant available and we must also have the most efficient methods available to maintain any such plant. Past methods of carrying out maintenance-of-way work have to be carefully examined, and it must be determined if there are better ways of doing such work. One will have to look at each facet of the work required and determine how much track time will be required to do the required maintenance. This, then, will tell you what work windows are required.

The number of trains per day to be operated will be an indication of what the plant

has to produce. If the maintenance time required does not permit all trains to be operated, we have a very serious problem. The options opened to us as maintenance people then become: What can we do to insure that, one, we have a plant in place which will require less maintenance than the plant presently in place; and, two, what can we do to develop tests and put in place more efficient machines, so that with less track time we can do more maintenance work?

Provide Stable Subgrade

So far as the plant is concerned, there are a number of ways to provide a plant which will require minimal maintenance in terms of what we presently have. Starting with the present structure, present lines can be upgraded. The subgrade must be such that it provides adequate support. Bank widening, proper protection where required, and any locations where instability is a problem must be corrected.

Only the best available pressed-rock ballast should be used. It must meet stringent specifications to insure it will not weather or break down under heavy traffic.

Track ties should be pre-stressed concrete. They must, and I cannot over-emphasize this, they must be properly designed for the loads which are to be carried and they must be manufactured under stringent control. Concrete ties must use the best fastening system available. We cannot afford to have any of the fastening system break down in a short period of time.

Rail must be of the most efficient design to insure long life. Most importantly, the chemical composition of the rail steel must be such that it is strong enough to resist deformation under high wheel loads, and at the same time, provide sufficient resistance to impact so that impact-type fractures are reduced to a minimum.

Based on current technology, it appears that some form of alloy steel and heat treatment will provide such a rail. It is our intention to commence testing early in 1983 of some 500 tons of such rail, using Japanese low-alloy head-hardened steel rails.

Bridges are also a part of the railway plant, as are signals and communication systems. Bridges must be in proper condition and adequate for the loads to be carried. When bridges are replaced, they must be designed to insure minimum maintenance. CP Rail has designed and installed a large number of bridges which have all of these features. The signal system must be such that it not only handles the traffic efficiently, but is reliable and easy to maintain. I would like to say more about bridges a little later.

Having put in place the plant which is the best state-of-the-art, we now, of course, have to maintain it. With heavy traffic, quite obviously, we'll have to work within minimum time blocks, or windows, if you prefer.

Track maintenance, as well as track construction, used to be highly labor intensive. Most functions were carried out manually, with some use made of a limited variety of machines. The track was divided into sections, approximately eight miles in length, and the Section Foreman and his crew of section men were responsible for most aspects of the maintenance of that section of track, renewing ties, surfacing, lining track, spot rail renewals and so on, were essentially manual functions.

During the 1960's, CP Rail, and other railways began working in conjunction with manufacturers of railway maintenance equipment to accelerate the mechanization of large-scale track-maintenance methods. This was in response to rapidly increasing wage rates, which dictated that fewer people had to look after longer sections of track. At the same time, the life expectancy of track components was decreasing as axle loadings and total tons hauled increased significantly.

Production Gangs Take Over

More machines were developed to aid in track maintenance work and soon most major maintenance functions were being carried out by mechanized production gangs which moved from territory to territory. We still have track sections, but they now range from 15 to 40 miles in length. The reduced number of track section gangs or track maintenance gangs, as they are referred to now, comprising from two to seven men each, perform the routine functions necessary for the day-to-day operation.

Large mechanized gangs are employed to distribute and relay rail with new or second

and materials and pick up the released rails nd fastenings, to renew ballast, including ndercutting and cleaning ballast, to re-lace defective ties and to surface and line he track.

The disadvantage associated in using nechanized gangs as compared to section ang type of maintenance is that the gangs an work efficiently only if provision is nade for a certain minimum amount of on-rack time for the work to be done. A single ime-slot or window of five or six hours is ormally required between trains to work ffectively. In some instances, however, angs may be able to move in and clear for rains more readily and only two or three ime blocks of only a few hours each will e sufficient.

The requirement for track time for the angs could quite conceivably interfere with he operation of trains. The increased use of irge mechanized gangs over the past few ears has coincided with the increase in ton-age being handled by the railway, so the roblem has become more severe.

Until several years ago the coordination f work time-blocks with train schedules as handled on a local basis with various perating headquarters across the sytem. his often led to complications on adjacent erritories.

lan Blocks on System Basis

Some time ago a program was imple-ented on CP Rail to plan the efficient oordination of track-maintenance work locks and train schedules on a system basis. n meetings arranged early each year be-ween system and regional engineering and ransportation departments, a comprehen-ive plan is drawn up to set the time for the ork blocks for the different mechanized, rack-maintenance gangs and alter the sched-les of certain trains so that, where practica-le, important traffic is not unduly delayed ven if the train moves from one region to nother.

The plan is published and distributed to ll concerned and updated weekly through-ut the work season. It shows, specifi-ally, the time periods during which work an be carried out, what trains must be leared before, during and/or after the work period, and what the total delay will be for a train from its point of origin to its final destination.

During the past number of years, we've been closely associated with track machin-ery and methods for carrying out mainte-nance work. As a result of discussions with various suppliers and the efforts of other railways, the present machines now in use have evolved. This was a time-consuming process, however, and has considered that it's time to start telling people what it is that we want in the future. To give you an idea of what has or should be further developed, here are some of the machines which I believe will improve productivity.

Employs Large Rail Change-out Machine

The rail change-out machine. This is a self-propelled rail-renewal machine which changes both rails simultaneously. It is a very large machine and while the one we have is still presenting some problems, the potential at the present is to do a very efficient job.

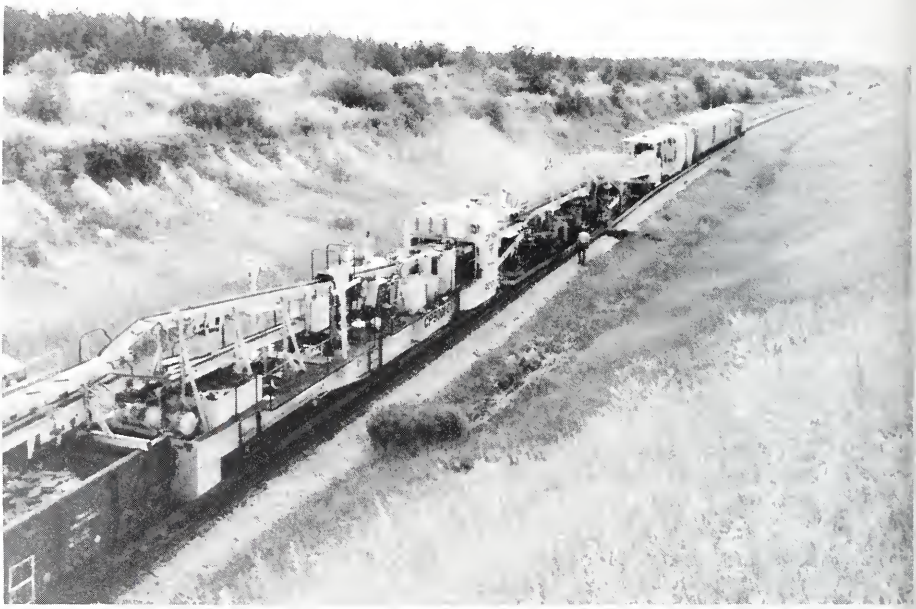
Your attention is now directed to a few slides showing this equipment in operation.

One of the first operations is to remove the spikes from the old rail ahead of the rail change-out machine. Rail anchors are also removed at this time. The CWR strings are placed alongside the existing track. The CWR strings are supported on special roll-ers placed on the ties which eases longitu-dinal movement of the rails during laying operations, particularly on curves.

Two self-propelled material loaders are used, one for rail anchors, and the other for track spikes. An operator places nails in the ties along the center line of the track im-mediately ahead of the RCO machine. This slide shows the center-line nailing machine.

When the rail change-out machine arrives at the work site, the new CWR is placed on rollers of the RCO. The new rail is connected to the existing rail that is in the track. This is the main control panel. The red lights refer to the different work stations of the machine.

I'm missing a few slides. I don't have the slides that show the old tie plates being picked up by the rotating magnetic wheels of the RCO or the new tie plates being depos-ited from the chutes onto the prepared ties.



Overview of RCO.

Employees loading new tie plates onto conveyors to be carried to RCO.

Back end of RCO.

However, this slide shows the position of the rail on the new tie plates.

This is the line-spiker station. It is difficult to see in this slide, but there is a device between the rails which is called the follower and it simply references itself to the nails that have been placed in the ties and the line rail is referenced to those nails.

The gauge-spiker station is just to the rear, on the other side of the machine.

There are two tie-plate conveyors. The new tie plates are handled on the lower conveyor and must, of course, be positioned so that the cants are correct before plates are carried down the chutes onto the ties. Of course, the upper conveyor conveys the old tie plates back to cars to the rear.

This is the rail change-out machine in operation. If you'll note the dust at the cribber station, which is situated between the tie-plugging and the adzer station. The old rail is threaded out over the top of the new rail. The machine is going away from us in this particular slide.

This is at the back of the operation. This is where we make a constant check of the track gauge as the work progesses. It was quite cool last spring when these pictures were taken, and this particular slide shows the dual rail heater and also, just ahead of it, the rail vibrator and ahead of it, again, is another rail heater which is not actually in operation. It must work at least one string behind the RCO in conjunction with adjusting the CWR strings to the preferred laying temperatures.

Behind that operation are the rail-anchor applicators, three of them on each rail. And then we have the dual-head rail spikers. Following that we thermit field-weld the joints to join the CWR strings. This slide shows the ignition of the thermit charge and the crucible over the rail joint.

The track is surfaced and lined immediately behind the rail-laying operation. And, of course, this particular slide shows the completed job.

Restore the lights for a few more minutes, please.

Other New Machines are Proposed

We have asked manufacturers to look into spiking machines which can be operated by one man. Four machines should be capable of keeping up to the RCO. The machine should have capacity to carry the day's requirements for spikes which should be fed automatically into the machines so that all the operator has to do is to manipulate an operating lever.

Present ballast-undercutting-cleaning machines are slow. If you can average 700 to 900 feet per hour you are doing well with a present machine. On rock-ballast territories we should not have to waste existing ballast simply because it is too slow and expensive to undercut and clean it. Successive ballast raises introduced other major problems which affect the track structure, bridges and highway crossings. To correct these problems is expensive and time consuming.

To overcome the problem we need a machine which is capable of undercutting and cleaning ballast at a rate of some four to five times greater than that for equipment now in use. Other machine improvements are also required, such as tie-renewal equipment, and smaller machines for use by track forces on a daily basis.

Another important part of maintenance is to keep the equipment in proper operating condition. Proper maintenance facilities are required. Mechanics, electricians, hydraulic people must be properly trained and know the machines they are to work on. Operators must be properly trained and be able to not only operate the machines but also have some knowledge of the machines so that minor adjustments and part replacements can be done. You will find that with the new and more efficient machines in the future, much more electronic equipment will be present.

Maintenance gangs will have to be assigned work cars so that equipment, when it has to be moved, can be loaded, tied down and unloaded in the least possible time. Each machine should have its alloted space so that when unloaded it is in its proper location in the working consist.

The men who operate the machines and all others in the gang must be housed in the cars that are not only properly equipped, but must be comfortable and provide a desirable environment. CP Rail has embarked on a program to replace the old style cars with equipment having modern facilities, including air conditioning. This may sound ex-

New boarding cars.

Cook car.

travagant but, in reality, it is a necessity. Boarding cars do become very hot during the summer months.

We must also be in a position to work at odd hours due to train operations and other factors. For instance, it may be to our advantage to start work during the summer months, say, from 0500 to 1300. This working period would require the men to retire during hot period of certain days and air conditioning will provide an environment in which proper rest can be obtained. Naturally, boarding cars of this type are not cheap.

Our new rail gang consist for the RCO, shown on the far side, costs some $3 million.

Could I have the lights once again, please.

The rail gang consist comprises some 30 cars. These are the walk-in freezers at one end of the provision car.

This is an interior view of the cook car. By the way, this particular car was one of the more expensive ones. I understand that it costs something in the order of $190,000.

This is the air-conditioned dining room. This is a locker car, which is separate from the living quarters so they can leave their work clothes there prior to going to their bedrooms and so forth.

This is a shower car. In the foreground, to the right, there are clothes washers and dryers.

This is a typical four-man supervisor car. This is an eight-man sleeper. This is a recreation car. There are three of these cars in the gang. This is a stainless steel potable-water tank. It has a capacity of 9200 gallons. And this is a power car, which contains two generators.

Can I have the lights once again, please.

Has Many Miles of Bridges

There are approximately 3500 railway bridges on CP Rail, totalling about 85 track miles of which 57 miles are steel spans, 25 miles are timber trestles and three miles are concrete structures. In addition to the wear and tear from ever-increasing railway traffic, these structures are exposed to frost, ice, wind, erosion, landslide, earthquake and flood. They are often difficult and hazardous and in remote locations and the task of maintaining this array of structures presents a multitude of engineering problems.

We have many bridges over 85 years old, which were originally built for much lighter traffic than they carry today and designed before the development of modern materials, methods, and specifications. Constant upgrading and renewal is necessary. Other new bridges are required for new lines, new services and changes in traffic.

Prior to 1960 nearly all railway bridges were either of timber or of riveted-steel construction with open timber decks. Since that time, however, the railway has availed itself of welded construction and bolted connections for new steel bridges. Ballast and deck construction is now standard in the design of all new spans slated for main-line service and a policy to eliminate timber bridges on main lines has also been adopted.

To insure that all bridges are maintained in a condition safe for the passage of trains, each and every bridge is inspected twice annually by the Division Engineer and Bridge & Building Masters. All bridges requiring special attention are inspected by representatives of the Chief Engineer's Office prior to establishing repair work required. Repair work can vary from ordinary repairs to structural modifications to major renewals. And the choice usually depends on the age and loading history of the structure, its physical condition and, especially, the extent of corrosion and the frequency of trains.

On larger spans, such as trusses, deck trusses and through-girder spans, only the floor systems and a few structural elements are seriously affected by fatigue or corrosion. Consequently, deterioration is usually limited to those components of such structures and it is generally more economical to repair or replace the affected structural elements than to undertake a major renewal of the complete span.

Environment Becomes Larger Problem

I would like to say a few words about another important aspect of maintenance. Our image as a good corporate citizen, insofar as the environment is concerned, is not too favorable with a number of people. Today, and in the future, this will become more and more of a problem in our everyday work. We must live up to the fact that we have the eyes of the public on us and, in many cases, we are going to be in trouble if

CP Rail train at Notch Hill, B.C.

we do not pay more attention to our work habits and what effect these have on our surrounding environment.

Those of you whose responsibility it is to supervise our maintenance work would be well advised to insure that whatever it is that you are having done will not affect the environment. For instance, when an oil change is required for a machine, the oil should not be drained to the ground wherever the machine happens to be located with no effort made to clean up the resulting mess. To compound this adventure, the oil container can should not then be thrown onto the right-of-way.

We do not pay enough attention to our actions when we are in the vicinity of our rivers and lakes. We have no license to pollute in any way any part of the country. Tie butts should not be thrown down high fills supposedly out of sight. Has it ever occurred to any of us what a horrendous job it would be to remove these to some other location?

In the future environment protection will become more and more a part of our daily work and I suggest that now is the time to start doing something about it. If we do not clean up our act, I can assure you, in today's enlightened environment, you will have nothing but trouble on your hands.

In summary, maintenance work on railways will become more difficult in terms of having the flexibility which we have had in the past. We must continue to develop new and more efficient machines, have properly trained employees, proper living accommodations, and do our work—not only as efficiently—but also with respect to our surrounding environment.

Thank you for your attention. (Applause)

President Sutherland: Thank you, Mr. Jardine, for speaking to us today. We would be most pleased to have you stay for all or some of our sessions if your schedule will permit.

Introduction of M. C. Purbick

At this time, I would like to call on Herb Webb to introduce our next speaker. Herb.

H. G. Webb: First, I've got to make a comment about that last talk. I knew Karl Sutherland was up to something, but air-conditioning, television, private bedrooms! I'm going to have to watch our Navahos, they're going to head for Canada. Or maybe I will, they look pretty fancy.

It is my pleasure to introduce Mr. M. C. Purbick, Director of Civil engineering for the British Rail.

Can everybody hear in the back, even without my voice? Yep, they're all waving, so they are awake. It's nice to see such a big group, too.

As I understand it, the Director of Civil Engineering is about the equivalent in the United States of our Chief Engineer, so that places him in a position for all of us as we hear his talk.

He is a graduate of London University. He went to work for the Great Western Railroad in 1946, in Britain. He worked all kinds of maintenance-of-way and engineering jobs, including Chief Engineer of two different regions. So you can see, Number One, why he looks a little bit weather-beaten, a little bit like a maintenance man, and a guy that's put in a lot of work in his life.

He was very concerned with some of the first electrification in Britain. He's been in his present position for seven years. He is a member of the Federal Engineering Association in Britain. He's also a member of the AREA here in the United States. I would also say that one of his attributes, is that he's also a very ardent golfer. You know, that really classes him—he's a good railroader and golfer.

It's my pleasure to introduce Mr. Purbick, Director of Civil Engineering, British Rail. (Applause)

Track Maintenance Renewal Approach On British Railways

By M. C. PURBRICK

Director of Civil Engineering, British Rail

Mr. President, ladies and gentlemen, can I say, first, how pleased I am to be here with you and to have a chance to speak with you, and I would like to thank your President for his very kind invitation to me. I would also like to thank Herb Webb for his very kind introduction. Perhaps the weather-beateness today is not so much from getting out on the track, but from the golfing activities.

I propose to talk about our approach to track maintenance—philosophy is rather a big word—I call it track-maintenance renewal approach that we use in the United Kingdom. Whilst there are similarities between all railways, everyone here will appreciate that there are many variable aspects to

M. C. Purbrick

this and the railways in this country are very different from those in our small island, particularly because we are still predominantly a passenger railway, although we do carry quite heavy freight traffic.

Can I have the lights out, please.

(Whereupon, there was a slide presentation with the accompanying remarks.)

The B.R.'s system is a little over 22,000 miles of track and this is on 11,000 miles of route, so most of our railway is double-track railway.

Operate High-speed Trains

On a number of the main-trunk routes passenger services are operated by the high-speed train. This runs at 125 miles an hour and has 17-ton axle weight. This fleet of high-speed trains do some 10 million miles a year. This is the highest in the world at that speed on track not specially built for that sort of operation. This is the original railway as constructed, in many cases, about 130 years ago. We have done some work on it, though.

On the same tracks freight trains with 25-ton, that's our long ton, 28 U. S. tons, operate with 100-ton gross weight vehicles. This is our biggest train, our biggest freight train, 3,300 gross tons, not very large compared with some of your trains. But that is the biggest freight train that operates in Western Europe.

To carry this traffic B.R. standard track has continuously welded rail, 113 pounds per yard, or 54 killograms per meter, flat-bottom rail with normal grade steel on concrete sleepers with Pandrol fastenings. The rail steel is produced by the continuous cast process, and we don't have very much problem with rolling flaws. To date, just about half of the system has been renewed in these materials.

The old material consists of bullhead rail in cast iron chairs and flat bottom rail on base plates, both on creosoted soft wood crossties. As these materials become life-expired they are replaced by this standard track on all lines where a long term future is foreseen. This is done on what I think you call an out-of-face basis.

Pre-stressed concrete sleepers have been in service on BR for over 35 years. The early concrete sleepers carry a bullhead rail in chairs and did not have the same intensive loading as sleepers on the main lines today; nonetheless, they continue to give excellent service on branch lines.

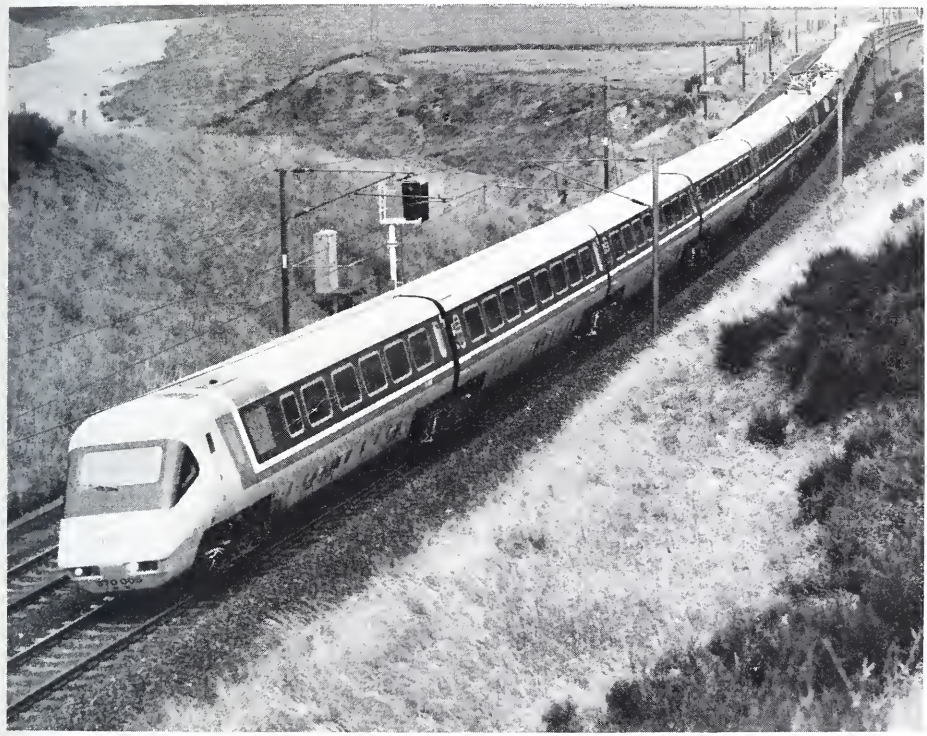
The concrete sleeper, more or less as we know it today, has been in service over 20 years. There has been over that period a number of changes in the details of the design to reduce the cost and to improve the technical performance. There is no doubt in my mind that the forecast life of these sleepers of 50 years will be achieved. We have, currently, over 20 million of them in the track and if we don't get the years then there will be some problems. I shan't be here to have to answer them, though.

A vital factor, however, in achieving this life is the maintenance of the track geometry and the ballast condition. If these are allowed to seriously deteriorate, the life of the concrete sleeper will be very considerably reduced.

In the early years of the development of the pre-stressed concrete sleeper, 33 different types of fastenings were evaluated in the U.K., both by track trials and by laboratory tests. There was a very wide range of performance and there were only two which emerged to meet the technical and economic criteria that we laid down. These were that there should be a high toe load giving good creep and torsional resistance; the consistency of the toe load for expected ranges of fastener deflection should be good; there should be no base plate; it should have a good fatigue life; there should be no requirement for regular nut tightening; there should be positive control of gauge; there should be good electrical insulatory properties, and there should be direct fixing onto the concrete sleepers.

The two systems that emerged were the Pandrol and the Spring Hoop Clip. The need to use a clip which was compatible with the third-rail electrified track, which we have on about 15 percent of our system, and the fact that the SHC were only capable of being used on concrete sleepers whereas with the Pandrol fastening you can use them on timber sleepers with suitable base plates, led in 1963 to the decision to standardize on the Pandrol clip.

And there you see our pre-stressed concrete sleeper with the pad, the insulator and the two clips shown on this slide.



The British Railways Advanced Passenger Train (APT) operates on the West Coast Mainline between Glasgow and London at speeds to 150 mph. The track structure uses concrete ties, Pandrol fastenings, and 113 pound CWR.

The British Railways High Speed Trains (HST) are diesel powered trainsets operating between all major population centers of the United Kingdom at sustained speeds of 125 mph.

Renew 600 Miles of Track Annually

Each year some 600 miles of old track reaches the end of its life, primarily due to decay of the soft wood sleeper. As I have said earlier, BR's policy is to renew this track if the line has an insured future with concrete sleepers and continuous welded rail. In many cases, the rail has a worthwhile future life remaining, and is re-used in lower category lines by cropping off the dipped ends with the fishbolt holes and welding into continuous lengths.

The rails, new and second-hand, are welded into 800-yard lengths at our own flash-butt welding depots using AI welders. Badly side-worn rail is generally not suitable for re-use except for very low speeds because the reversal of the worn profile produces instability of the riding in the vehicles, and produces bogie truck hunting. A major step forward enabling us to re-use these rails in the higher-speed lines is the production of the rail-planing machine. This is a machine which is basically one of our standard tamping machines.

We have a requirement for our tamping machines that they run at 60 miles an hour, otherwise they wouldn't get anywhere if they didn't run at that speed. Therefore, they all have big bogie trucks on them.

There's no tamping banks on this machine, but in place of it is the rail-planing head, which you see here. And that runs along the rail, both rails at the same time, and the planing tools, which are held in the center of that tool holder, takes a cut on the rail head and seven passes totally replaces the worn profile back to the original profile.

This process is, as I say, going to significantly increase the amount of second-hand rail that we can re-use, both in the main lines and in the secondary lines.

Our records have shown that the number of rail failures of all types that we find is increasing over the years and we now need to cascade to lower category lines long welded rail. And we need to pick up that rail from the ground and we have machines to do this.

We have a problem with corrugations in our country which is slightly different from corrugations as experienced in North America. They are much shorter wave lengths. This, again, is something which is fairly new and growing considerably over the last ten years and, despite considerable research activity, no means have so far been found to avoid their growth. The problem is being dealt with by grinding and we have grinding trains which grind about 1,250 miles of track a year.

The track-renewal system that we are currently introducing uses these beams that you see in this slide. They pick out the old jointed track in 60-foot long panels, that's the rails and the sleepers, and load them on wagons and then they pick off other wagons, new sleepers, properly stacked, of course, and lay them in position on the ground. The long welded rails are then placed in position by a machine running on the track. So this is a very simple method of track renewal and it saves quite a lot of money compared with the old system where we used to build up the panels to go back in in 60-foot lengths and then change the rails for the continuous welded rail.

As I say, we need to pick up the continuous welded rail and to re-use it after planing, or prior to planing, in the new position and this is the new machine that we have to pick up those rails. You have two jib arms which go through a special wagon which guides the rails up onto the flat wagons behind it and so we can pick up strings 800 yards long.

Use Igneous-rock Ballast

The provision of an adequate depth of good ballast, I think, is understood now throughout the world as far as concrete sleepers are concerned. On our trunk routes we require a minimum depth of 15 inches below the sleeper. The most important part of the stone is the wet attrition value because we have a fair amount of rain in our country and no really dry parts; and we find that only igneous rock can answer that. We had, for many years, a lot of limestone ballast and this is totally unsatisfactory for concrete sleepers.

The provision of the required depth of ballast is made by what we call ballast cleaning machines—I think you call them undercutters—immediately prior to track renewal.

This shows the latest machines that we have, fairly compact and, again, capable of running under their own power up to 60 miles an hour.

Major Work on Week Ends

The majority of track-renewal and re-ballasting works are carried out over the week-end in our intensively used system, probably on most of the important lines you've got 15 to 20 trains an hour, so there's no possibility of getting them to do work, or any major work, during the week. So we do our work at week-ends, that's when our Operating Department can give us the possession of the track we need.

Even so, there's still a lot of traffic on the week-ends, and whilst we do dispose of the ballast from the ballast-cleaning machines at line side, we haven't got nearly as much space as you have on this continent and, therefore, we do load or have to load a lot of the old spent ballast.

Previously, we used to stand wagons on the adjacent track where we could get it, but now we have a new system for loading ballast end on. This machine stands at the back of the ballast cleaner and the ballast is discharged into the end machine and then into skips. These skips are moved up and down the train by these small cranes running on rails on the wagons.

Computer Plans Whole Year's Work

There are some 2,000 individual track renewals and ballast-cleaning projects each year and to plan them, optimizing all resources required for their execution, a computer system is used. This system is known as CROWS, the Computerized Renewal of Way System, and has input into it the basic requirements for each of the individual projects. The computer then takes the most suitable and cheapest method of carrying out the work and programs the whole year's work dating every item and optimizing the use of all resources, including manpower, plant, materials, depot production, and more particularly, the track possessions and restrictions of speed.

We are now starting to run the program for 1984 and this may take a month or two to get all sorted out. But, then we are in a position to negotiate with the Operating Department if we haven't got enough speed districts or possessions to do our work. Then they can adjust the time-table, and that has to be done well in advance because the time-table has to be published so that everybody knows what time the trains are running and this is why we have to do it so far ahead.

Every job that is processed through the computer has a cost of its execution on the selected system printed out. As the work is carried out all the costs are charged through another computerized accountancy system and then this is interfaced with the CROWS program and the actual cost of each job is then compared to the planned cost and any divergence highlighted.

Develop Track-recording Car

Turning now to the maintenance of track, a major advancement has taken place in recent years, particularly with the advent of computers, is the modern recording car which has numerous accurate quality measurements of track geometry. About six years ago this capability was developed by our Research Department and resulted in our building our own recording car.

This is the car. It's in a standard passenger vehicle and it records accurately to one, plus or minus, millimeter at speeds from ten miles an hour to 125 miles an hour. It has to do this because it can run in the high-speed trains if we want it to.

The system is totally non-contact. There is no contact other than through the wheels of the vehicle.

The data is processed by an onboard computer which feeds a 12-channel analog recorder and also calculates track-quality statistics for every eighth of a mile, which are printed out by a character printer, which you see—no, you can't see it in this picture. Sorry.

That's the main-control desk inside the vehicle.

The data is also recorded on magnetic tape for subsequent input into the central computer system. The track statistics are analyzed and presented as Standard Deviation, which describes the average roughness of the eighth of a mile and as a count of the number of exceedences of a pre-set threshold value. The latter is necessary as otherwise on good quality track, the significance of one bad isolated defect will be lost.

This, in fact, shows the twists—I don't know whether you are familiar with that

term—and the dynamic cross-level on the left top. That's only a small section of the print-out. And you see, down the left-hand side, the eighth of a mile and the Standard Deviation is the first figure in each column. That's all times ten. I said that's one to ten, but it's times ten those figures.

This form of statistical data of track quality can be related directly to the riding characteristics of the different vehicles and their suspensions and also to ride comfort factors for passengers.

From these considerations track standards are set. Clearly they cannot be arrived at just by theoretical calculations, and in finalizing our standards we took a rather more pragmatic approach, otherwise we may have had to spend rather more money than we could afford on improving quality.

Speed Governs Track Quality

We classify our track for engineering purposes into 16 categories. There are four speed bands and four weight bands, and we set a track-quality standard in terms of the standard deviation for each of the speed bands.

These show the results plotted in a cumulative frequency plot and you can see that on the left-hand side is the percentage of the track on this particular route. On these particular routes, there are three routes shown here, and the standard deviation along the bottom. And the important aspect is that we expect 90 percent of a route should be better than the standard figure. And if you look down to the bottom, you can see the twists on the left-hand side. Ninety percent, on most of those cases, except one, the methodlog category line, is better than the 1.0 standard deviation figure.

This sort of information is a general overview to a Regional Engineer of the condition of the track over a particular route.

The data analysis from the computer is also presented in the form of a bar chart which compares current data with that from previous runs.

The detailed print-outs from the car show where maintenance is or will be needed and the tamping and lining machines, or the surface and lining machines—as I think you call them—which carry out most of our track maintenance are programmed to work only on these portions of track.

The recording car runs over the important main lines four times a year, and on the less important lines twice or three times a year.

All our tamping and lining is done with this type of machine. This shows you a picture of it earlier, with the planing heads on. This is our standard machine. They can run at 60 miles an hour and are high-production tamping machines.

Recording Car Determines Priority

I mentioned earlier the exceedence level counts, what we get out of our recording car, and these are set at two levels. The first requires immediate attention by the local section gang, and we hope we don't get too many of those. And then there's the second level, which requires action by the gang in the normal course of their work in the next two or three weeks.

The knowledge of the track condition that is available from this sort of system at all levels of the organization and the consequent control over track-maintenance input and costs are one of the most fundamental changes in track maintenance since mechanization of the track-maintenance process was introduced some 25 years ago.

When the tamping-machine programs are made out they form a framework for the work of our maintenance gangs and they are formulated some three months in advance, taking into account the seasonal variations.

Another Computer Plans Gang Work

The detailed working requirements for the gangs are also noted by the Area Civil Engineer, rather like your Roadmasters, and his supervisors during the course of their inspection. All these requirements, with a priority rating, are input into yet another computer system, this is called CAMP, Computer Aided Maintenance Planning, which is used to plan the work of each individual gang.

Ten days or so prior to the week for which the work for a gang is required, the supervisor inputs into the computer the likely level of manpower which will be available, taking into account sickness, holidays and that sort of thing.

The computer then calculates the amount of work that the labor available is capable of undertaking, taking items of work from its memory in the priority order, to fill the capacity and issues a schedule of work for each gang. All the calculations use work study based data and the output of the men is calculated at standard performance. In this way, the right work is carried out with good productivity without a bonus system.

At the end of each week, the work carried out is entered together with all the gang's time information for payroll purposes on a single document. This is then progressed through a further computer program which calculates the pay for the individual man and also puts on store in a data base all work done on each section of track for future analysis.

The gangs of track-maintenance men consist of about eight men. They are provided with a road vehicle which, besides conveying them to the site of work, has capacity to carry small items of materials, mobile mechanized equipment and other tools, and provides them messing accommodation, washing and cooking. Clearly, we don't need the sort of facilities that Mr. Jardine showed you just now because ours is a very compact system.

The gangs, however, cover about the same sort of lengths of track as the CP section gangs, some 50 miles in length, that is because then they are not all single lines. They may only cover about seven miles of geographical track.

Maintenance is Calculated in Detail

The manpower required to maintain a given length of track is calculated in detail, taking as a basis every cycle of maintenance for the various track categories, track materials and, again, using work-study-based data.

All pieces of track are not precisely the same and, therefore, provision in the sytem is made for extra work in special circumstances such as bad formation. We have a lot of bad clay formation in our country to be added to the basic formula.

With the quality control from the recording car and the feedback from the labor input into track maintenance, the manning can be controlled and, hence, the cost of track maintenance minimized.

Lastly, I would like to turn to a rather new development which we are pursuing in our system. This has the possibility, as I see it, of being another major step forward in improving the techniques of track maintenance and their contribution to the cost effectiveness of railways.

The track is sometimes referred to as the Permanent Way. We know, only too well, it is not permanent and needs attention at intervals to maintain the geometry standards for safe and comfortable running of traffic. The current vibratory-tamping techniques were developed in order to reduce the high labor content of the old manual maintenance system. Mechanical tamping is the mechanization of what we used to call the old "beater system" of maintenance. Beaters are a lot like pick axes with blunt heads.

Before mechanizaton on BR, the manual system used in most circumstances was the measured shovel packing system involving the measuring of quantities of chippings required to be placed under the sleeper to correct any void and to correct any dip in the longitudinal level of the rail.

The current tamping system requires retreatment over a cycle of up to three years, depending upon the traffic, the track material and the nature of the formation and drainage. As traffic passes over a newly tamped piece of track, deterioration gradually takes place until the track is approximately in the same state it was originally before it was tamped or surfaced. We call this the "ballast memory."

Mechanize Shovel Tamping

The measured shovel-packing sytem, if it was done properly, lasted much longer than machine tamping does today, but it was very labor intensive. It seemed to us that a mechanized meaure shovel packing system would have many advantages. And whilst the idea was not new, we thought it was about time we have another go at it. We have, therefore, now developed an experimental prototype machine to do this.

This slide shows the longitudinal level of a piece of track, and shows the bottom—the bottom of the slide shows what happens when track is tamped. The bottom line is the original shape of the track, before tamping.

The top line is the track after it's been tamped, which looks very good. This is an exaggerated scale, of course. And then the lines further down are after a fixed tonnage of traffic over the piece of track and you can see it goes down, again, as I said, to very near the same shape.

The top part of the slide shows the treatment with the stone grinding machine. And, again, the bottom line, the blue line, is the shape of the track before the stone grinder went through the track. And the top line shows the track after treatment.

This is not as good as the tamped track immediately after treatment. But you can see the situation after one week where the track is much better, and then after week 12 it's gone down rather more, but it's still got out some of the very big dips and that shows the sort of advantages that you can get with this technique.

Longer term trials of this machine have shown that, in fact, you can get probably four times the life of a treatment compared with mechanical tamping.

This is the experimental machine and it's a latch up of a very old tamping machine, but it's been converted to measure the weight of stone that needs to be placed underneath the sleepers to lift the sleepers and to pneumatically inject the stone through those small tools that you can see in the center of the picture.

We have a lot of work to do on making this system fully operational, but I have great hopes for it in the future.

I am coming to the end of my presentation, and I hope I've shown that my approach to track maintenance is to very much use the power of computers, when they are available to us, to make sure that everything is planned, costed and controlled so that we do our job in a cost-effective manner.

However, there are still many things, like this machine, where new ideas can be found to do our job in an improved manner. And I think everybody must be personally looking for these things.

I hope you've found some interest in what I've said. Thank you very much for your attention. (Applause)

Mr. Webb: Thank you, Mr. Purbrick.

We're a little ahead of time. If any of you have any questions, we surely would entertain them at this time. That was a very informative discussion of what I might class as how we ought to do it. Now some of us say: Gee, we do that too, but don't really. And I don't know what I'd do with a section every seven miles. Oh, I'd know what I'd do with it, but I'd be shocked. But I think that's how you maintain excellent track.

Any questions back there? I hear one, yes.

Member: I noticed on your chart that you were dividing your track in 16 classifications. It appeared that the maximum track density that you had was 12 million gross tons. Is that correct, or was I reading your chart wrong?

Mr. Purbrick: No, that's not the maximum that we have. We've got up to about 25 million tons, gross tons on one track.

Member: Twenty-five million would be about the top of the line?

Mr. Purbrick: Yes.

Member: Well, I refer to the next to the last slide on this ballast placement: it appeared that you go out in advance and measure and you need so much here and you skip five sleepers and then go down, unload 50 sleepers and skip ten. Is that correct?

Mr. Purbrick: Yes, that's right.

Member: That's measuring pretty close, then.

Mr. Webb: Thank you, Maxwell.

Yes, one back here.

Avoids Transposing of Rail

Member: Yes, sir. You said that your railroad avoids transposing rail because it causes an unstable ride characteristic.

Mr. Purbrick: Yes, that's correct.

Member: Did you say "truck hunting," that's the major reason you do not transpose?

Mr. Purbrick: Yes.

Member: Could you elaborate on that a little bit? Maybe when you found that out and how and whether or not corrugation or anything else has any effect on it?

Mr. Purbrick: This was clearly established—particularly for high speeds up to 80 miles per hour. It's a nasty experience. It's not unsafe, but you could notice a very high frequency—vibration and that sort of thing. And we just couldn't continue to operate like that and so we stopped transposing. It was identified that the bogie hunting took place

on the recently transposed rail. It was a practical experience, I really must say.

Mr. Webb: Are there any others?

Yes, Dave.

Member: Yes, I would like to ask: What kind of standards the Mechanical Department have in maintaining wheels so that you don't have some of the problems with the concrete ties that we seem to have on this continent?

Mr. Purbrick: Well, we pursue the Mechanical Department to make sure that they do maintain their wheels, but we don't always achieve it. (Laughter)

Our concrete ties now are designed, and have been for a good while, to take this into account because of the problem of the high dynamic loading that you get from your flats I think is what you mean. And our ties now have bending reinforcement on the rail seat.

Treatment of Unstable Clay Soil

Member: Mr. Purbrick, John Water has always talked about the layer mud or clay, rather, that underlies the freight yards in Great Britain. Would you relate that to the work that's being done in getting track facilities and the ballast section up?

Mr. Purbrick: I'm not very clear?

Member: Well, there's a layer of clay that causes a great deal of instability problems that's very close to the surface at the track and it squishes out.

Mr. Purbrick: Yes, quite a big portion of our track is on clay formation. There are hundreds of feet of it in some places, the blackened sort of clay, and our standard treatment for that formation is to introduce a sand blanket. We use a higher material that leads into the sand blanket and it's up to 12 inches thick. That's our standard treatment for the clay formation.

Mr. Webb: Are there any others? Yes.

From the floor: Mr. Purbrick, you mentioned something about taking a pragmatic approach after you developed your track geometry statistics. I would assume that was taking into account the traffic density or some cost aspect. Is that correct?

Mr. Purbrick: Yes, it was the cost aspect. Our Research Department produced those figures and we looked at those and thought about them, but we adopted some in some categories of track and in others we adopted a slightly lower because we couldn't afford the cost of going up to the deviational standards.

Mr. Webb: Yes, Dave. One more.

From the floor: How many maintenance-of-way or civil-engineering employees does BR employ?

Mr. Purbrick: Maintenance of way? About 32,000 total, that's maintenance and renewal. We split our operation into the maintenance of track and renewal of tracks, so 32,000 is the total figure.

That, I might add, is one of the lowest in Europe per mile. And this is, per mile, is what we base it on. Much better than the Japanese.

Mr. Webb: I'd like to crowd one question in, while you think.

On your re-profiling machine, first, have you done it very long? Second, do you have a rough guideline of how you program that? What are your limits before you actually reprofile the original head?

Mr. Purbrick: We have had the machine now for nearly 18 months and we have another four on order now.

The limits, we control our reuse of the rail on a depth dimension and we have a depth of rail limit for each category of track. And, provided the finished profile of that section is within that limit for re-use, there's no problem. The important thing about planing is to make sure that when you stop to make your cut that you go deep enough to take out any slight variation, any wave profile in the section of the rail. That's the only criteria. And that needs a little judgment. That's where the experience of the use of this machine comes into play.

Mr. Webb: Okay. Thank you.

Maxwell Mitchell.

Mr. Mitchell: When you re-profile your rail, I know you said you restored it back to its original contour. I would certainly think that on a curved cut rail we would not be able to go to that extent. But the running surface and the other side, you could re-profile to its original contour; and that being the case, could you not then after you re-profile it, transpose it and have satisfactory operations?

Mr. Purbrick: Yes, that's possible and it is done. But I think I mentioned that we have a

problem with fatigue failures on the high-speed tonnage area and we need to re-use those rails elsewhere. So we do pick them up with the crane I showed, we do use the cranes, and take them to assembly lines and profile them there. So we do, in fact, transpose rails when we can place them on the back side.

Mr. Mitchell: When you speak of a fatigue problem, how do you characterize a fatigue problem? In terms of defects per unit of time or track? What kind of limits do you use for your high-speed tracks?

Mr. Purbrick: The number of failures, really, is per mile of track per year. We've clocked that and are operating, pretty much, on that basis.

Mr. Webb: It sounds like you have a considerable lead on us in track maintenance planning, which I have a little interest in.

Anybody else got any?

Mr. Purbrick: I'd like to comment on that. I think it's our type of operation that makes this planning necessary. If you're running the intensity of traffic, that's all the trains, of course, freight intermixed with passenger traffic, then you've got to plan, you've got no alternative. I think that you have not that problem. And I would like to have your operating plan, frankly.

Member: Sir, on the long shovel-tamping that you were talking about, that machine that you showed at the end of your presentation, you showed this machine that you were trying to develop to push or inject ballast under the ties, do you have to use a smaller gradation ballast, and would you have to carry that supply with you on that machine?

Mr. Purbrick: Yes, that's correct. The stone that's injected is the same size or very similar to the size that was used in the operator shovel-packing system, and that is carried on the machine in a hopper.

From the floor: That's similar, then, to what we used to call the old sand-packing. Is that correct?

Mr. Purbrick: I don't recognize that.

From the floor: In other words, small gradation ballast, chips almost.

Mr. Purbrick: Chips, yes, that's correct. That sort of material.

Member: On your re-profiling machine, could you tell me what type of a cutter you're using?

Mr. Purbrick: That's tungsten carbide cutting tools, small tools.

Member: And is this on a wheel which is also turning?

Mr. Purbrick: No, it's in a tool holder, just like a straight planing operation that you'd use on planing switches.

Mr. Webb: Thank you, Mr. Purbrick. I think it's been a highlight of our conference so far. You have inspired many people to thought. Thank you very much. (Applause)

President Sutherland: Thank you, Mr. Purbrick, for keeping us up-to-date on what's happening on British Rail. We know you've traveled a long distance to come to talk to us and we thank you for that and we wish you a safe journey back home.

This concludes the final joint session of the Bridge and Bulding and Roadmasters' Associations.

We're running a bit ahead of time so we are going to have a short break and the Roadmasters will reconvene in this room and the Bridge and Building Association meeting will be held in the room directly behind the podium. I think it's Room No. 3.

President Hyma, do you have anything to add at this time?

President Hyma: Only that we will be reconvening immediately and would like to get started at about five after 10:00 o'clock.

President Sutherland: Therefore, I now declare this Joint Session adjourned.

WEDNESDAY MORNING

10:00 A.M.

President Hyma: Will all those present please be seated. I would like to call this session of the B&B Association to order.

The By-Laws dictate that I must now present a report containing a statement of the general conditions of the Association. Ordinarily, this consists of some comments in regard to the membership being up or down by a small amount and a reference to the Treasurer's report saying that we are in good shape financially. I wish that I could say the same, but unfortunately, I cannot. Membership at present stands at 699 compared to 683 at this time last year, which is very satisfactory considering the mergers and consolidations that have taken place and the reductions in force that have been made in the railroad industry.

However, our financial situation has been eroding for the past several years with steadily increasing expenses and declining advertising revenues. These deficits have been covered by transferring funds from our savings account but now the savings are gone. The Treasurer's report tomorrow will show a balance of some $7,000 as of August 31. This is somewhat misleading however, since subsequent expenditures primarily for the printing of the Proceedings and the publishers' share of advertising revenues have reduced us to a red ink situation coming into the conference.

I don't want to belabor this matter because this Association is not set up to be a money-making operation, but we do have to remain solvent to fulfill our purpose which is the advancement of knowledge pertaining to the design, construction and maintenance of railroad structures.

Your Executive Committee has taken action to correct the financial situation. As you know, dues were raised for the first time since 1965 from $7 to $12. A new advertising contract was negotiated raising the price of the advertising and increasing our percentage of the gross revenue. The guaranteed minimum income from advertising was also set at a higher figure. Finally, the registration fee for this conference was set at $25 and our share should put us back in the black.

I would like to ask your help however, to further improve the situation. First, pay your dues promptly. Second, urge all of your people who are eligible for membership to join the Asociation. Finally, point out to the various suppliers, manufacturers, contractors and consultants with whom you do business, the advantages of advertising in our Proceedings. One advertisement brings in as much revenue as twenty memberships. Just send the name of any potential advertiser to our secretary and we will do the rest.

So much for the financial condition. We've survived through several wars and depressions since 1891 and we'll make it through this period also.

Now, for a much more pleasant task. I want to ask Joe Chambers, Bridge Construction Engineer, Missouri Pacific Railroad, and our immediate past president, to call our other past presidents in attendance today to come forward to be recognized.

Mr. Chambers: J. A. Jorlett; E. E. Runde; W. C. Sturm; J. R. Williams; T. L. Fuller; N. D. Bryant; R. D. Hellweg.

President Hyma: Thank you Mr. Chambers. It is a pleasure to have you gentlemen with us today. We owe a great deal to you.

Mr. Chambers wears another hat too. He is also the Chairman of the Nominating Committee and will, at this time, present the slate of candidates recommended by the Committee for consideration in the election to be held tomorrow in our business session.

Report of Nominating Committee

Mr. Chambers: The Nominating Committee of the American Railway Bridge and Building Association respectfully submits to the membership the following slate of officers and directors with the recommenda-

tion that they be elected for the terms specified:

For President—O. C. Denz, Supervisor Building Maintenance, Milwaukee Road

For Senior Vice President—J. Budzileni, Senior Structural Designer, Illinois Central Gulf

For Junior Vice President—D. A. Bessey, Assistant Chief Engineer Structures, Milwaukee Road

For Directors—term expiring 1985:

D. R. Ladner, Assistant Engineer, C&NW Transportation Company

R. A. Tallent, Jr., Process Engineer Structures, Southern

T. E. Kuhn, Engineer Special Projects, Missouri Pacific

For Treasurer—P. H. Saletnik, Engineer Buildings, C&NW Transportation Company

President Hyma: Thank you Mr. Chambers. Do we have any additional nominations from the floor at this time? No? Tomorrow's election then will be based on the slate as presented.

We will now proceed with our program and those at the head table can take seats in the audience.

Our first speaker will be introduced by Mr. Budzileni, Junior Vice President and Chairman of the Special Features Committee.

Mr. Budzileni: Thank you President Hyma. I would like to introduce Mr. Robert M. Hochheiser. Mr. Hochheiser has a Bachelor of Engineering Degree, specializing in Mechanical Engineering from Rutgers University. He is a Registered Professional Engineer in Ohio.

Mr. Hochheiser has been active in noise control engineering since 1960 when he designed and then managed acoustic test facilities for Worthington Corporation. Originally joining Industrial Acoustics Company in 1963 as Project Engineer, he worked extensively on the design and development of utility silencers, enclosures and barriers.

From 1965 to 1971, he was Manager, Fan/Compressor Acoustics for the General Electric Company in Evendale, Ohio, where he managed a group responsible for the acoustic design of the CF6 bypass engine now used on the DC10 and A300 aircraft. During this time, he was also Program Manager for Contract FA68WA-1960 on fan engine noise research in addition to being responsible for planning and analysis on the original NASA "Quiet Engine" Program.

In 1971, Mr. Hochheiser joined Barry Division of the Barry Wright Corporation as Vice President, responsible for management, engineering and marketing aspects of that company's noise control product lines.

Rejoining IAC in 1978, Mr. Hochheiser has been instrumental in the development and introduction of several new noise control products.

Over the past twelve years Mr. Hochheiser has prepared and delivered papers on acoustics and noise and vibration control for the American Society of Mechanical Engineers, the American Society for Metals, the American Institute of Industrial Engineers, and the Society of Manufacturing Engineers. He has also lectured on noise and vibration control at Northeastern University and at Carnegie Mellon University.

May I present Robert M. Hochheiser.

Robert Hochheiser

Noise Control in Railroad Shops and Yards

This paper describes the EPA railroad noise source standards slated to become effective in January 1984, the OSHA regulations already in effect, and proven methods of dealing with each.

EPA Regulation

On January 15, 1984, EPA regulations will take effect regarding several specific railyard noise sources:

Category	Criteria
Stationary Switcher Locomotive	Idle Throttle Setting: 70 dBA at 100 ft* Any Throttle Setting except idle: 87 dBA at 100 ft*
Moving Switcher Locomotive	90 dBA at 100 ft*
Car Coupling Operations	92 dBA at receiving property
Load Cell Test Stand	78 dBA at 100 ft*
Active Retarders	83 dBA at receiving property

* Noise source deemed to be in compliance if noise level does not exceed 65 dBA at receiving property.

These requirements were published in the Federal Register on January 4, 1980: 40CFR Part 201 "Noise Emission Standards for Transportation Equipment: Interstate Rail carriers".

One of the above categories, car coupling operations, can according to EPA be met by operational means—limiting coupling speeds to eight miles per hour. In the case of stationary and moving switcher locomotives, EPA recommends the installation of engine exhaust mufflers. The EPA has estimated that the effect of these mufflers is an average of 3 dB at idle and 4 dB at higher throttle ratings. With regard to active retarders and locomotive load test cells, a different situation exists. Significant levels of noise reduction are achievable for each but the technology for meeting criteria must take many factors into account.

Active Retarder Noise Control

Active retarders are used to control the velocity and spacing of free-rolling freight cars so that the speed at which cars enter a classification track is just sufficient to insure coupling. These retarders are mechanical devices which clamp a beam against the wheels of the cars, thereby creating a friction force which slows forward motion. In addition to slowing the car, however, the friction force produces and radiates an intense squealing noise.

Sound absorptive noise barriers placed on both sides of a retarder are a proven, effective means of complying with the EPA standard. The technology to evaluate the effectiveness of different barrier designs is documented in U.S. Department of Transportation report no. DOT-TSC-NHTSA-79-35 "Railroad Retarder Noise Reduction Study of Acoustical Barrier Configuration". The study was performed under contract to the Burlington Northern Railroad, Inc. who subcontracted the work to the Industrial Acoustics Company.

During the course of this study, noise measurements were made near a railroad retarder system with and without acoustical barriers of various configurations installed on both sides of each retarder. Barrier

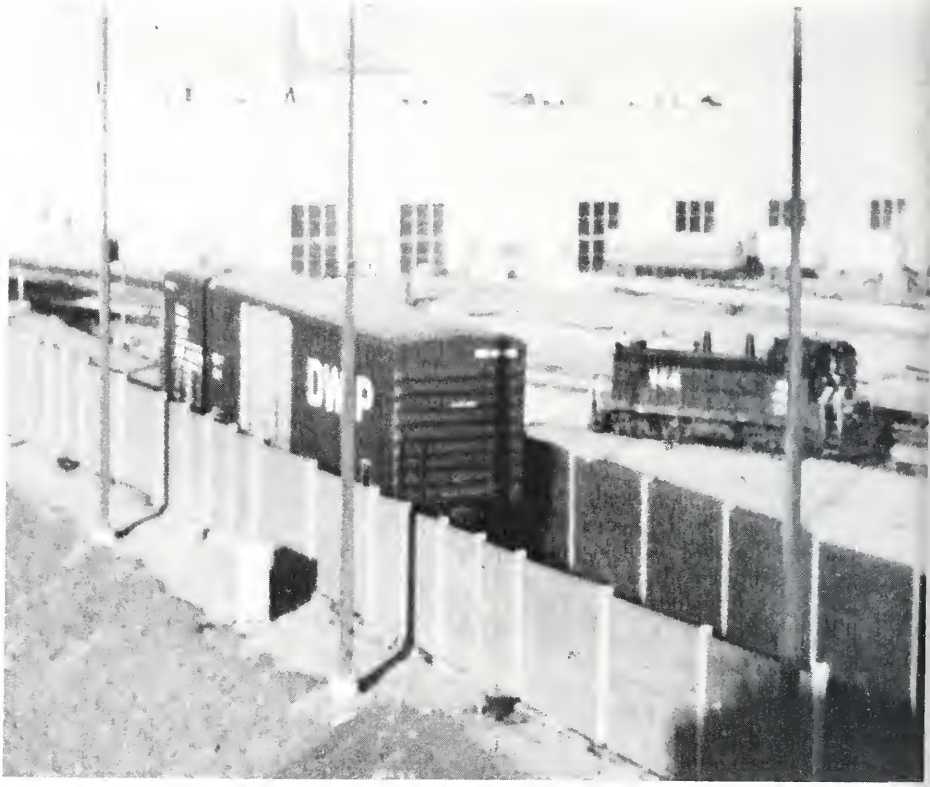


FIGURE 1

heights ranged from 4 feet to 12 feet, and lenghts extended from 0 to 22 feet beyond retarder entrance and exit. Typical retarder barriers tested are shown in Figures 1 and 2.

Results of the study conclusively showed that sound absorptive retarder barriers are significantly more effective than acoustically reflective barriers. Figure 3 plots typical insertion loss data at 100 ft. from a barrier at 90 degrees to the track. As an example of the effectiveness of the sound absorptive barriers, this figure shows that in order to provide the same insertion loss as a 6 ft high absorptive barrier, a reflective barrier would have to be 12 ft high.

Figure 4 shows four out of nine pairs of sound absorptive barriers as seen from the yard master tower at the Burlington Northern Northtown classification yard in Fridley, Minnesota. The group and master retarder barriers permanently installed here are 8 ft high, extending approximately 12 ft beyond the entering and leaving end of the retarders. The barriers are located 9 ft from both sides of the center of the track and have sound absorptive surfaces facing inward towards the wheels.

These barriers are assembled from modular steel panels installed between 5 inch wide flanged structural columns anchored in concrete. Each panel is 4 inches thick and constructed of welded steel frame and face sheets. The sound absorbing materials between the face sheets are mildew resistant, verminproof, and resistant to oil, dust and water. Perforated galvanized steel protects the sound absorptive material facing the track while the outside face of each panel is solid, impervious galvanized steel. The barriers are designed to be disassembled and reassembled repeatedly without loss of acoustical performance, a necessary feature

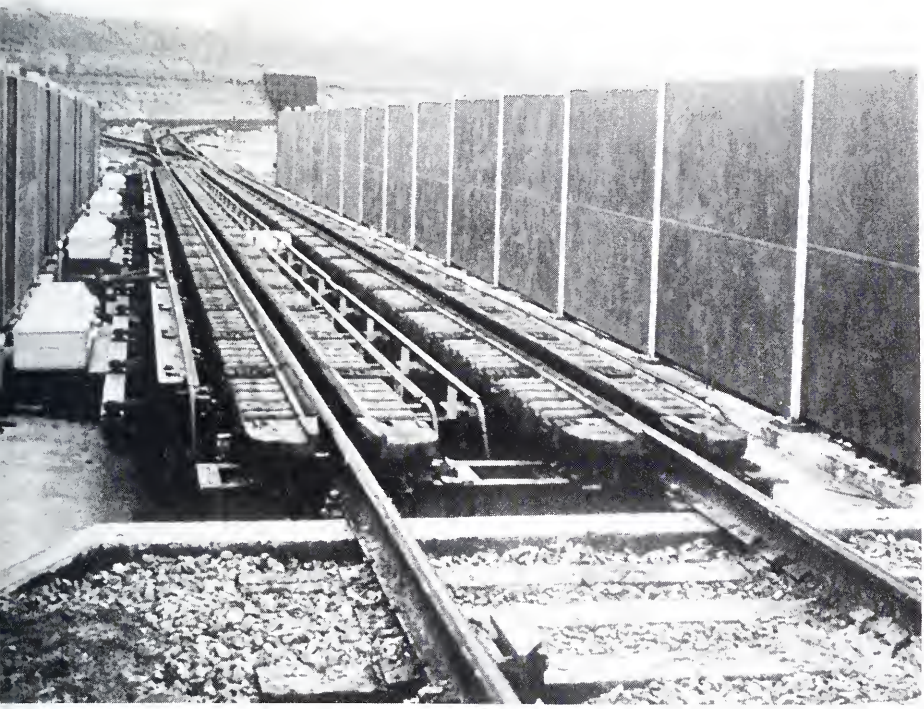


FIGURE 2

n the event of derailment or retarder eplacement. For personnel safety and re-arder maintenance and adjustment, access loors are incorporated in each barrier. Acoustic performance characteristics of the arrier panels are shown in Table 1. Advan-ages of the barrier system shown here re numerous: a proven solution to retarder oise, weather-treated designs that stand up o high winds, rain, heat and cold, reliable erformance for day-in, day-out operation, inimum space, and long term durability. By the time the EPA regulations go into ffect, these barriers will have seen almost a ecade of successful usage.

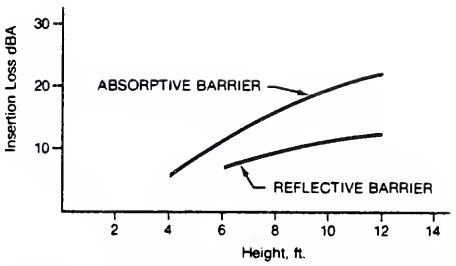


FIGURE 3 — TEST DATA ON A SPECIFIC RETARDER INSTALLATION SHOWS THAT 6 FT HIGH ABSORPTIVE BARRIERS WERE EQUIVALENT TO 12 FT HIGH REFLECTIVE BARRIERS.

oad Test Cells

Figure 5 shows an engine test cell we esigned and manufactured to house two eparate engine load test compartments at ie Illinois Central Gulf Railroad's Paducah hops.

Each cell is 42 ft long, 42 ft wide, 16 ft high nd includes special air intake and exhaust blowers and silencers that allow the cells to be ventilated with 48,000 CFM of outside air. Although exhaust temperatures are as high as 250°F, cell temperature reaches a maximum of only 110°F.

This structure was assembled from modular steel acoustic panels mated together with steel rollformed H-joiners and steel corner joiners, roof channels and trim. Access for engines rated at over 4000 Hp is accom-

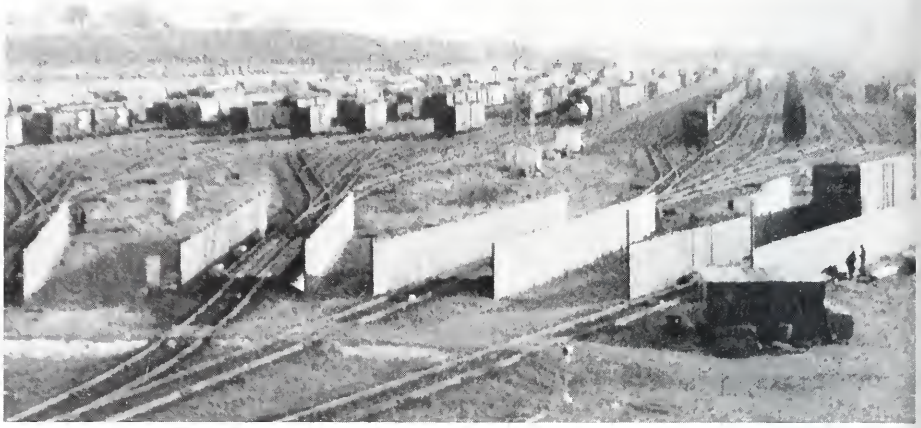


FIGURE 4

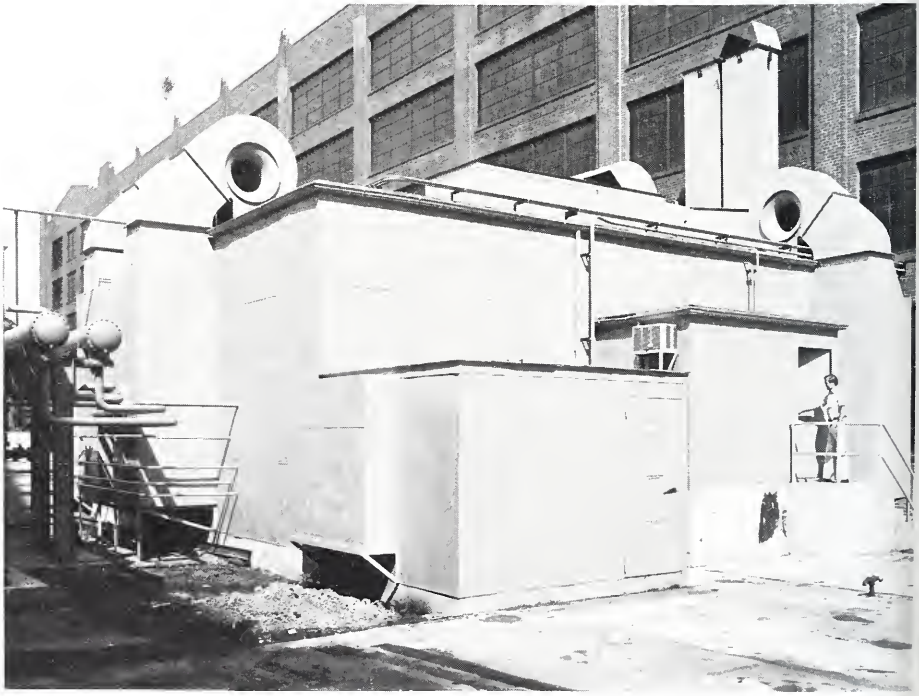


FIGURE 5—Noise control system housing two separate engine load test compartments. Special aerodynamic design required balance between exhaust and intake silencers to provide flexibility for positioning exhaust stacks for diesel engines ranging from 1000 to 4000 hp.

TABLE 1
TRANSMISSION LOSS AND SOUND ABSORPTION COEFFICIENTS

OCTAVE BAND CENTER FREQUENCIES, Hz	125	250	500	1000	2000	4000
TRANSMISSION LOSS, dB	23	30	42	51	59	58
SOUND ABSORPTION COEFFICIENT,	0.56	0.99	0.99	0.97	0.95	0.90

IGURE 6—Entrance to test cell through acoustical doors. The cell's concrete floor is situated ver a specially constructed support base geared to the weight of engines in position. Hood bove the engine is the entrance of the exhaust-venting system.

FIGURE 7—Operators monitor engine under test. Since engine noise is only a faint rumble, the men do not have to wear personal hearing protectors.

plished by means of an 8′ x 14′ double leaf door, Figure 6, that is acoustically compatible with the walls and roof of each cell. Each door leaf is fitted with unique cam-lift hinges that provide a tight acoustic compression seal to be achieved without a sill when the door is closed. This design allows the heavy engines to be readily moved in and out of each cell when the door is opened. Smaller personnel doors have similar acoustical and access capabilities.

In airconditioned control rooms, Figure 7, operates monitor tests both with instruments and visually through double pane acoustic windows. Separating the control room from the cell itself is an acoustic double wall consisting of two 4 inch thick steel acoustic panel walls separated by a 4 inch air space.

Particular attention was paid to the fact that acoustically reflective surfaces can cause reverberant build-up of sound within a closed structure such as a test cell. Accordingly, internal wall surfaces of cells and control rooms are sound absorptive, a feature that had negligible effect on cost while enabling the noise reduction of the structure to be improved significantly compared to acoustically reflective structures such as masonry or concrete.

The acoustic performance of the cell is summarized in Table 2. Levels of as high as 115 dBA within the cell were reduced to less than 80 dBA in the shop and to 64 dBA in the control room, both below OSHA limits. Outside the cell at 25 feet, the level was 81 dBA. At a distance of 100 ft, this outside level would correspond to approximately 69 dBA, well below the EPA limits.

U.S. Occupational Safety & Health Administration (OSHA) Standards

As of August 1981, OSHA noise exposure standards consisted of a two-stage program where hearing conservation measures became mandatory at 85 dBA for an 8-hour day but feasible engineering or administrative noise controls are required when exposure exceeds 90 dBA. Defining terms,

TABLE 2 — SOUND PRESSURE LEVELS MEASURED IN THE ENGINE TEST CELL FACILITY AT ILLINOIS CENTRAL GULF RAILROAD, PADUCAH, KENTUCKY
ALL TEST DATA TAKEN WITH ENGINE AT 8th NOTCH

Measured Position	Scale		Octave Band Center Frequency							
	A	C	63	125	250	500	1000	2000	4000	8000
Inside Engine Room										
Position 1	115	121	106	107	114	113	110	105	102	97
Position 2	114	120	107	112	110	112	109	105	103	98
Inside Control Room	64	96	79	71	64	64	50	43	34	29
Specification	75	–	–	–	–	–	–	–	–	–
Ambient	57	72	65	65	58	52	50	43	34	29
Outside At 25 Feet	81	89	83	85	83	80	75	69	60	49
Specification	85	–	–	–	–	–	–	–	–	–
Ambient	75	83	75	79	77	72	70	64	55	45
Inside Shop										
10 Feet From Door	79	92	89	84	79	76	74	70	66	57
20 Feet From Door	78	88	83	84	77	75	72	68	64	53
Shop Ambient	78	88	79	79	74	74	71	69	63	56

–*Hearing Conservation Programs* include annual audiometric testing and provision of hearing protectors.

–*Engineering Controls* include reducing machinery noise through redesign, replacement with quieter equipment or by reducing the transmission of noise along the path from source to receiver including enclosing the noise source or noise receiver.

–*Administrative Controls* include reducing noise exposure by limiting the time an employee is exposed to given noise levels.

. Criteria for Engineering or Administrative Controls

Feasible administrative or engineering ontrols shall be utilized if noise dose D is reater than 1.0 in accordance with the ollowing equation:

$$D = \left(\frac{C_1}{T_1}\right) + \left(\frac{C_2}{T_2}\right) \cdots \left(\frac{C_n}{T_n}\right)$$

vhere:

) = Daily noise dose (must not exceed unity)

C = Actual exposure time at a given noise level

T = Permissible exposure time at the level in accordance with Table 3

. OSHA Criteria for Hearing Conversation Programs

Employers shall administer continuing, ffective hearing conversation programs wherever employee noise exposures equal or exceed an 8-hour time weighted average of 85 dBA, or, equivalently, a dose of 50% measured according to the following equation:

$$D = 100\left[\left(\frac{C_1}{T_1}\right) + \left(\frac{C_2}{T_2}\right) \cdots \left(\frac{C_n}{T_n}\right)\right]$$

where:

D = Workday dose in percent

1, 2, 3, = Periods of exposure to different dBA levels

C = Actual exposure time at different levels

T = Permissible exposure time at a given level in accordance with Table 4

As an example of the application of OSHA criteria, an 8-hour time weighted average of 89 dBA would not require engineering or administrative controls, but would require a hearing conservation program.

Also, OSHA specifies maximum allowable background noise levels permissible in audiometric test rooms used in hearing conservation programs. OSHA is considering, however, a revision that will lower the permissible background levels. The current OSHA standards as well as lower levels proposed in early 1981 are shown in Table 5. Several means for meeting OSHA regulations are described below:

TABLE 3 — PERMISSIBLE EXPOSURE, OSHA CRITERIA FOR ENGINEERING OR ADMINISTRATIVE CONTROLS

Duration Per Day, Hr	Permissible Exposure "Slow" Response, dBA
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or Less	115

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

TABLE 4 — PERMISSIBLE EXPOSURE, OSHA CRITERIA FOR HEARING CONSERVATION PROGRAMS

A-weighted Sound Level, L (dB)	Reference Duration, T (hr)	A-weighted Sound Level, L (dB)	Reference Duration, T (hr)
80	32.0	92	6.2
81	27.9	93	5.3
82	24.3	94	4.6
83	21.1	95	4.0
84	18.4	96	3.5
85	16.0	97	3.0
86	13.9	98	2.6
87	12.1	99	2.3
88	10.6	100	2.0
89	9.2	101	1.7
90	8.0	102	1.5
91	7.0	103	1.4

Noise Control Structures

Noise control structures inhibit the transmission of sound along the path between the noise source and the locations at which the noise would be objectionable or represent a health hazard. Noise control structures can take one of five basic forms.

- An enclosure around the noise source
- An enclosure around the people
- A full partition between the people and the noise source
- Partial noise barriers
- Sound cladding to minimize reflection of sound from acoustically hard surfaces.

Machinery Enclosures

Load Test Cells of the type we have just discussed are, of course, noise source enclosures. For machinery noise in shop areas, we have designed and manufactured similar structures, Figure 8. Also constructed of modular steel panels, these enclosures can be used for equipment such as grinders, welders, cold headers, lathes, presses, electric lifts and other noisy machinery. Note that more is required with these enclosures than to simply put up walls; barrier free access, windows, lighting, electrical systems and silenced ventilation must all be considered so that the noise control capacity of the

TABLE 5 — ALLOWABLE BACKGROUNG NOISE LEVELS IN AUDIOMETRIC ROOMS (OSHA)

	Octave Band Center Frequency				
	500	1000	2000	4000	8000
OSHA Standard as of August 1981 Octave Bands, dB	40	40	47	57	62
Proposed Revised OSHA Standard Octave Bands, dB	27	30	35	42	41

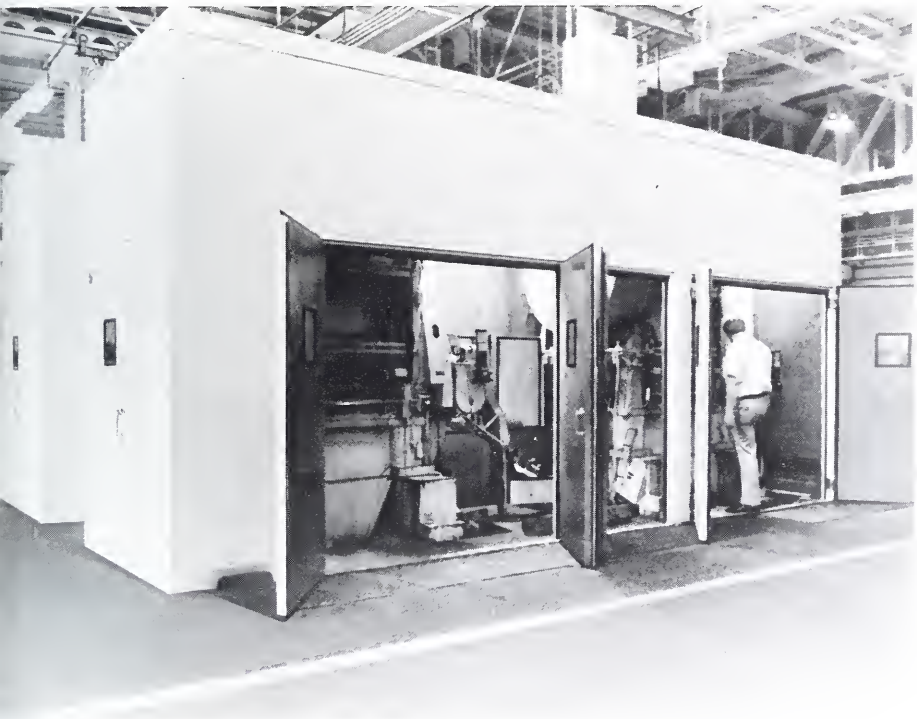


FIGURE 8—Machinery noise enclosure

tructure is not hampered. Well executed nachinery enclosures can reduce noise by as nuch as 30 dBA.

'lat Car Power Units

To service the Canadian National Rail-'ays' many miles of track, maintenance rews continuously ride the rails. Rolling ccommodations for the men consist of our-person, self-contained living units nounted on flat cars.

Every flat car is also equipped with a diesel-electric generator set to provide the electricity required for a crew's personal needs and comfort. Each power source features an air-cooled diesel engine coupled to an alternator. Sets are rated at 12.5 kW.

With the surface area of a flat car limited, the generating sets sit only three feet away from the living quarters. So, to prevent the noise made by the generator set from being disturbing to a crew's quarters, we designed a noise-attenuating enclosure for installa-

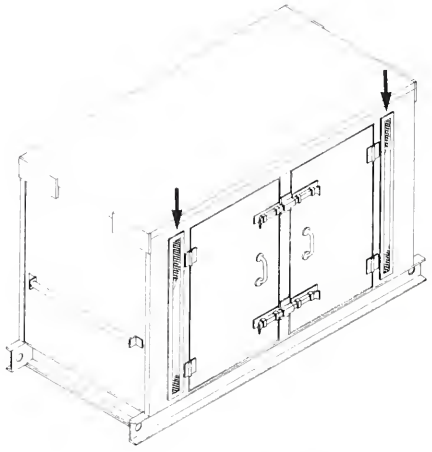


FIGURE 9—Enclosure for diesel-electric generator sets mounted on flatcars of the Canadian National Railways emphasizes the silencer grills ( ) of the cooling-air system's intake and discharge vents.

tion about each of 65 generator sets in service. This enclosure is shown in Figures 9, 10, and 11.

Eight feet long, four feet wide, and four and a half feet high, each enclosure has doors on both the front and rear faces to facilitate maintenance and can be readily removed for servicing, if necessary. A weathertight seamless roof protects all enclosed components from adverse weather conditions.

Vibration is controlled by vibration isolators chosen so that the natural frequency would be approximately 8 Hz.

The dynamic loads of rail movement also influenced enclosure design. Each enclosure has been planned to withstand longitudinal, vertical, and lateral G loadings of ten, four and one respectively.

Another design factor important to the functioning of the noise reduction setup is a self-contained ventilation system powered by a 1700 CFM fan with a static head of only 0.5 i.w.g. This system, complete with silencers, allows cooling air to enter and exit the enclosure. The air passage maintains heat ambients inside the enclosure at no more than 20° F over outside temperatures.

Acoustical tests carried out on the silencing system have shown that the enclosure reduces noise of the generator set 20 dBA or more to bring sound levels in the living quarters to below NC 40, about the same as the levels in a hotel room.

Personnel Noise Shelters and Offices

Providing a typical noise reduction capability of 30 dBA overall and 42 dB in the speech frequencies, personnel noise shelters, Figure 12, are self-contained rooms with lighting, electricity, and heating or air conditioning as required. Suitably weatherproofed, they can serve as gate houses, shipping and receiving offices, guard posts, traffic control stations, monitoring booths, control rooms and communication centers in the vicinity of sidings, dumping stations, wayside operations, freight yards and shop areas. Silenced ventilation systems, combined with soundproof doors and single or double glazed windows, provide an environment in which personnel can function comfortably within OSHA noise limits while having full visibility of operations.

Figure 13 shows one of these rooms designed with a slanted window wall for improved sightlines as an operator pulpit over a coal car shakeout operation. Although the noise level at the car is as great as 140 dBA, levels in the pulpit are no greater than 80 dBA.

These rooms are factory assembled complete with floor and roof, and fork liftable. Available in a variety of sizes and configurations, they can be shipped directly to the site, put in place, connected to a power source, and used immediately. Should changing needs require relocation of the room at a later date, it can be quickly moved to the new location.

Another way to isolate people from noise is to enclose groups of personnel in factory offices. Figure 14 shows a factory office complete with lighting, ventilation, double glazed acoustic windows and no-sill, barrier free doors. Available in virtually any size, these offices provide A-weighted noise reduction of as much as 35 dBA. In addition, a panel weight of less than 10 lbs per sq ft means that the entire structure could be installed in the mezzanine location as shown without additional structural supports.

A major advantage of the enclosures, partitions, barriers, noise shelters and of-

FIGURE 10

FIGURE 11

FIGURES 10 and 11—Enclosure for diesel-electric generator set shown from the rear and the side. The generator set within is situated atop a fuel tank. Crew's quarters are to the right in both views.

ices shown above is that the panels, joiners rim and hardware are pre-engineered in a ariety of standard sizes, all of which are coustically rated in accordance with AS-M specifications. This system is particularly suitable for those who prefer to lay out and install their own installations without having to theorize or compromise about performance, accessibility, visibility or durability. At the same time, costly field labor is minimized by factory assembly and supervision.

FIGURE 12—Personnel noise shelter

All photos courtesy of Industrial Acoustics Company, Inc.

FIGURE 13—Operator pulpit personnel noise shelter

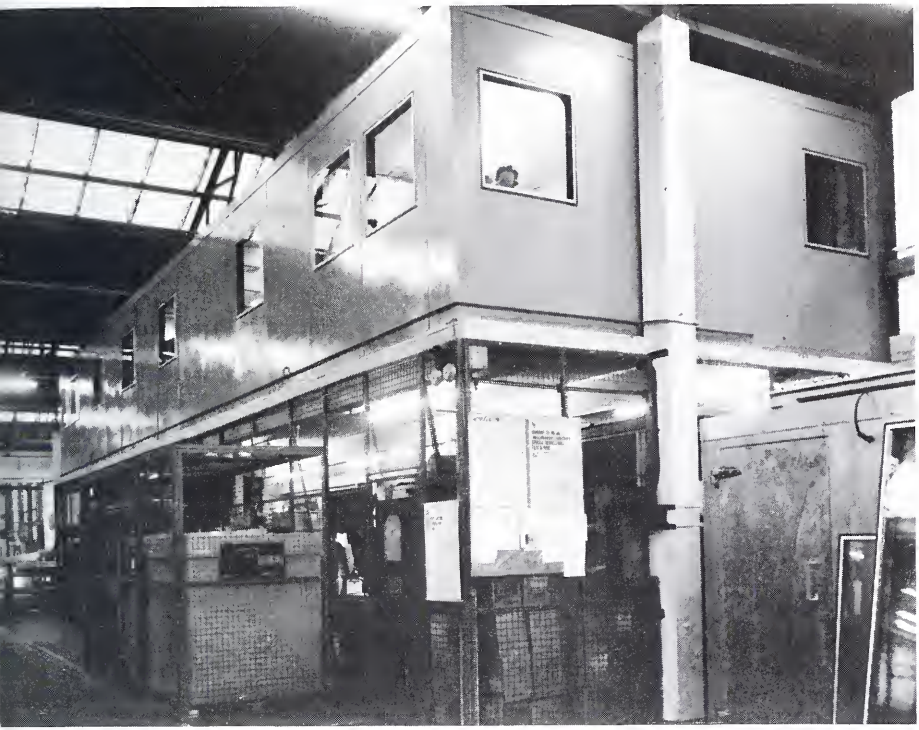


FIGURE 14—Soundproofed factory office

Audiometric Test Rooms

To conduct audiometric testing in accordance with OSHA mandated hearing conservation programs, we also have designed a number of test rooms and suites specifically configured for high noise reduction and audiometric testing. Self contained instrument jack panels, these rooms are available in versions ranging from portable units that will fit through most doors, Figure 15, to large suites with separate control and examination rooms. Typical noise reduction characteristics of audiometric test rooms range from NIC 39 to NIC 75.

The Importance of Sound Absorption

Earlier, we discussed the benefits to be derived from using sound absorptive surfaces on barriers and load cell walls. Similar benefits are achieved with absorption on other acoustic structures. Sound absorptive surfaces minimize reverberant build up of sound and have been shown to improve the noise reduction of assembled enclosures by as much as 10-20 dB in the speech frequency range. Enclosures with sound absorptive surfaces can therefore be far more effective than those made of concrete, plaster or other constructions.

All of the acoustic structures described in this paper, therefore, includes sound absorptive surfaces facing towards the noise source on partial barriers, full partitions and machinery enclosures, and also facing the inside of personnel enclosures, control rooms, factory offices and audiometric test rooms.

Fire Ratings and Blast Ratings

We have recently developed as standard designs, panels that feature STC 45 acoustic performance with optional 1 hour (solid

FIGURE 15—Audiometric test booth

side) and 1 1/2 hour (absorptive side) UL label fire ratings. For acoustically compatible access, we also have a series of STC 47 acoustic doors with 1 hour and 1 1/2 hour UL label fire ratings. All fire rated structures have the same modularity and accessibility features described earlier.

Optional blast pressure rated structures and doors are also available and can withstand instantaneous blast pressure of 1 psi with doors operable after blast.

Packless Silencers

Another new development is the packless silencer. The packless silencer uses no fiberglass, no mineral wool, no foam, and no acoustical fill of any kind. In conventional silencers, unprotected acoustic fill can absorb flammable matter in an air stream, leading to potentially unsafe conditions.

The complete absence of fill, however, combined with ease of cleaning and draining, makes the packless silencer well suited for a variety of facilities handling fuels and other hazardous materials. Acoustically, the excellent low frequency Dynamic Insertion Loss characteristics of the packless silencer, Figure 16, means that it will be highly suitable for virtually any application.

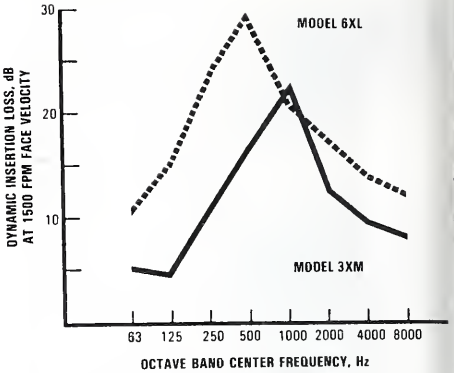


FIGURE 16—Packless silencer

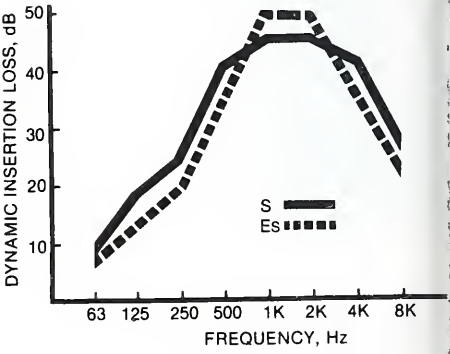


FIGURE 17—Acoustical efficiency of energy saving silencer (Type Es) and Type S Silencer

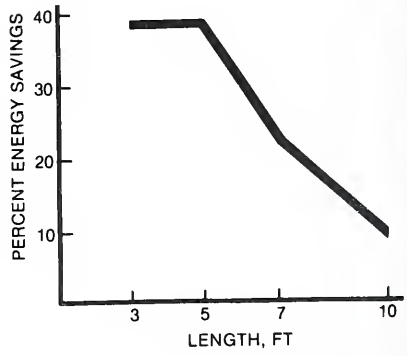
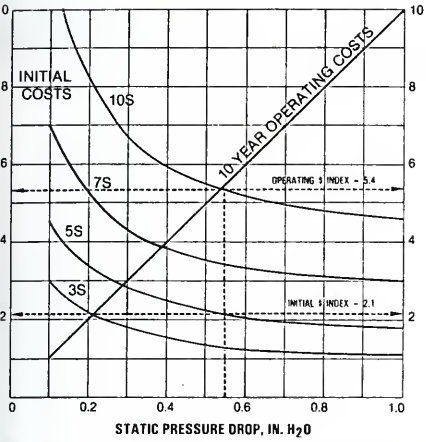


FIGURE 18—Energy savings of Type Es compared to Type S with same airflow, face velocity, and length.



GURE 19—Operating index plus initial dex gives total relative cost index for com-rison with other models.

nergy Saving Silencers

We have developed a new Energy saving pe Es rectangular silencer that provides proximately the same high acoustic inser-n loss characteristics as the type S ndard silencer, but with considerably duced pressure drop. Figure 17 compares e acoustical performance of these two encers and Figure 18 shows energy savings the order of 40% for the Type Es silencer. For picking the right energy saving si-ncer, we also now have a series of curves to ow designers to select silencers on the sis of first cost as well as long term erating costs. A typical example is shown Figure 19.

Summary

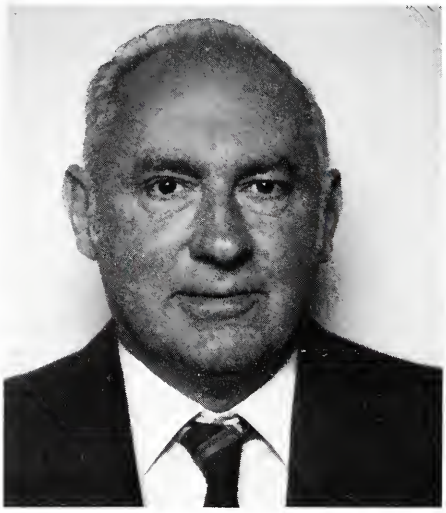
A variety of proven designs are available for meeting OSHA and EPA railroad noise criteria. Using field proven construction and certified acoustic performance ratings, these designs offer the railroad industry no-guesswork reliability and long term durability without having to "re-invent the wheel" of design tasks such as minimizing acoustical leaks, achieving door seals that work properly, and providing access visibility and silenced ventilation without detracting from structural or acoustical integrity.

President Hyma: Thank you Mr. Hochheiser for a timely presentation. Noise suppression is a problem that is going to demand more attention in the future.

Our next speaker will be introduced by Mr. Denz, Senior Vice President and Program Chairman. Mr. Denz.

Mr. Denz: I wish to introduce Mr. J. S. C. Frost who will talk to you about "Glulam Bridge Girders on the British Columbia Railway". Mr. Frost is a member of the staff of the British Columbia Railway. His credentials include a degree from the University of British Columbia in Civil Engineering. He is a registered professional engineer in the British Columbia Association of Professional Engineers. Mr. Frost has worked with the British Columbia Railway from prior to his graduation from the University in 1946 to the present. Since his employment with the British Columbia Railway as Assistant Engineer in Squamish, he has progressed to his present position of Engineer of Bridges and Structures in North Vancouver. Mr. Frost.

The Use of Glu-Laminated Girder Bridges British Columbia Railway



J. S. C. Frost

Mr. Chairman, Gentlemen:

It gives me a great deal of pleasure to be here today and to take part in your Bridge and Building sessions and to introduce you to the value of the use of Glu-Laminated Timber in the construction of railway bridges on the British Columbia Railway.

As mentioned in my introduction, I have been associated with the B.C. Railway since 1946, working in a number of positions in the Engineering Department, and am presently the Engineer of Bridges and Structures, with headquarters in the Chief Engineer's office in North Vancouver, B.C.

Although I have held a number of different positions in the Engineering Department, Bridges and Structures have always been my foremost interest. I've spent a good deal of time working and travelling with B & B Masters and love to reminisce about some that I've known and to recall some of the peculiar characteristics and related stories that are associated with individuals that fill such positions. As I suspect I am addressing a number of B & B Masters, you will know what I am referring to in this regard.

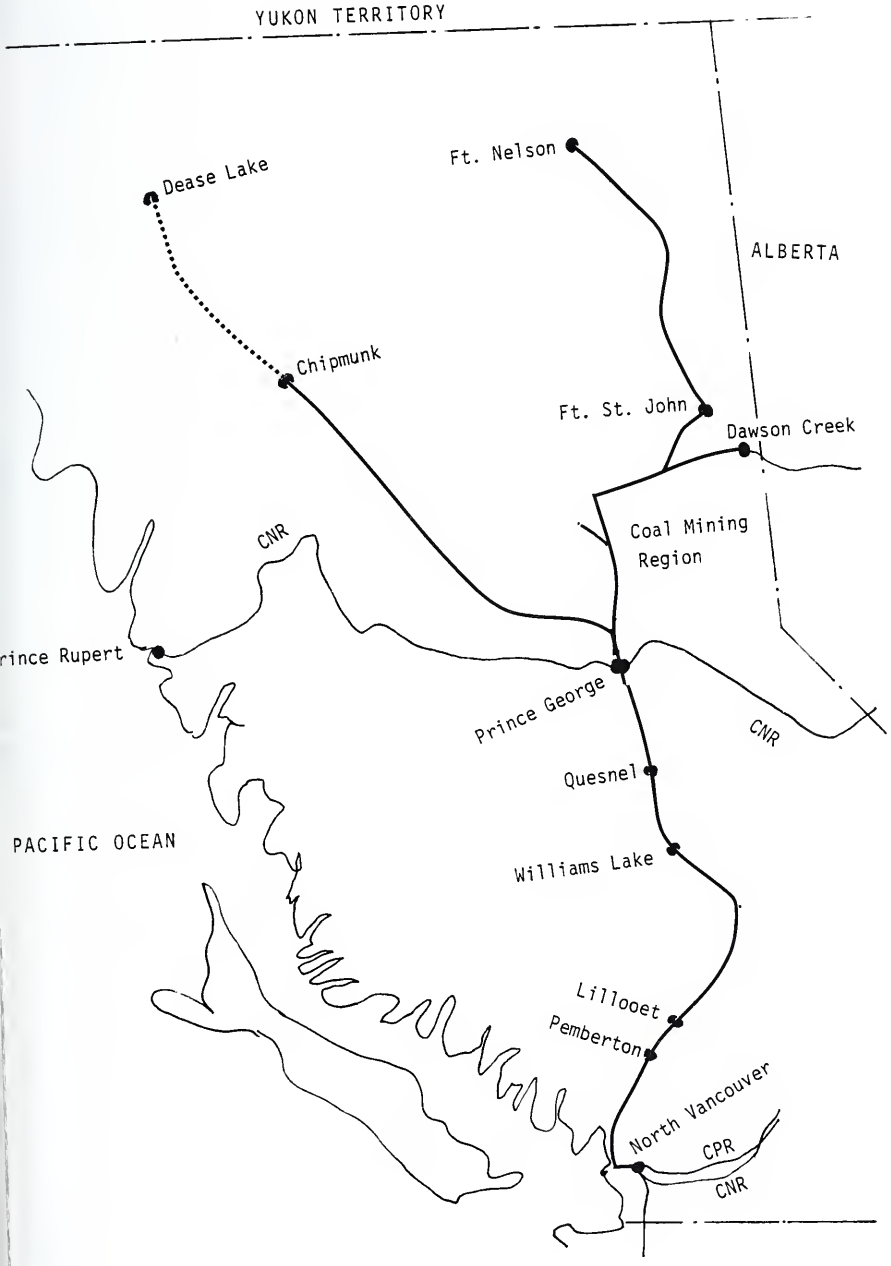
The time allotted for the presentation is approximately 45 minutes, and in order that we will have enough time to show a number of slides and have time for a few questions and comments, I've prepared a typewritten presentation for your reference, which also includes some miscellaneous technical literature, copies of reports, etc., which you will find of interest. I will attempt to follow this outline generally, however will take the liberty to ad lib. If any questions come up during the talk, please make a note of them and I will attempt to answer them at the end of the presentation or at some convenient time afterward.

Historical Development

As I do not know what your familiarity or extent of knowledge of the British Columbia Railway is, I have prepared a brief historical sketch which will also serve to show the parallel in the use of Glu-Laminated Timber Bridge Spans with the expansion of the Railway during a certain period of development.

Prior to 1972, the B.C. Railway was called the Pacific Great Eastern Railway, and it was not many years ago that when you said that you worked for the Pacific Great Eastern Railway, that people in B.C. especially in the Vancouver area, would look at you as some sort of oddity. A good many people did not know where its terminuses were; the only thing they thought of was "it started nowhere and ended nowhere". When you explained that its southern terminus was Squamish and the northern terminus was Quesnel, they had no idea except that Squamish was some mysterious place somewhere up the coast of B.C. and that Quesnel was somewhere in the vast interior of the province. This is not the situation today.

The Pacific Great Eastern Railway



BRITISH COLUMBIA RAILWAY SYSTEM MAP

named after the Great Eastern Railway in Great Britain, was incorporated and construction started in 1912, and a service between North Vancouver and Horseshoe Bay was inaugurated on January 1st, 1914. Operation on this portion of the Railway was suspended sometime in the 1920's. Prior to 1912, a logging railroad, known as the Howe Sound and Northern, operated through Squamish for about 8.5 miles.

This Railroad was acquired by the Pacific Great Eastern Railway and extended northward towards Prince George where it was intended that a connection would be made with the Grand Trunk Pacific Railway (now the C.N. Railway) so as to give that Railway a Vancouver outlet as well as a connection to the Orient through Prince Rupert. A traffic agreement was in effect between the two railways. The Squamish to Quesnel portion of the line was completed and in operation by July 1st, 1921, with a barge water connection to the City of Vancouver from Squamish. The portion of the Railway between Quesnel and Prince George was partially completed, except for the construction of two large bridges over the Cottonwood and Ahbau Rivers, and work was discontinued and not to be completed until the years 1949–1952 after the Second World War.

During the years from 1921 through to the early 1950's the Railway continued to operate between Squamish and Quesnel. During the Depression years there was very little money for maintenance, and then through the War years there were very few men available to carry out maintenance work; so things were at a very low ebb by the end of the War.

Most of the bridge structures on the original line were untreated pile and timber frame structures of the trestle type; a good number of timber Howe trusses and some steel structures. Some replacement work was carried out during these years, and the bridge steel fabricated for the Cottonwood Bridge north of Quesnel and never used, was used in replacement of some of our bridges in the Cheakamus Canyon north of Squamish.

Following the Second World War, considerable interest in the P.G.E. Railway was generated by the Government of the day. Upgrading work was undertaken with respect to the existing Railway to meet the needs of economic growth in the province and the movement of products (mostly timber) to the coast for shipment to world markets. It was not long until the Railway was shown to be an important resource transportation service, and extension of the Railway was undertaken.

In 1946 survey work was proceeded with in the Pine Pass area looking to the extension of the railway to the rich Peace River area which connection had been talked about for years. In 1947 a detail survey was carried out between Quesnel and Prince George and the original extremely difficult crossings of the Cottonwood and Ahbau Rivers were improved by means of an alignment revision, as well as improvement to other crossings further north by means of a second revision referred to as the Stone Creek Revision. Construction of the Quesnel to Prince George link was undertaken in 1949 and completed in 1952. A number of bridge structures on this new section were built of untreated timber except for the three larger bridge structures over the Cottonwood and Ahbau Rivers and Canyon Creek which were steel structures.

Following the connection to Prince George and due to increase of traffic generated, it was imperative to have a direct rail link to Vancouver as the barge system at Squamish could not begin to handle the traffic. By 1956 the rail line was connected from Squamish through North Vancouver with direct interchange with other railroads.

The Railway continued to expand and by 1958 had been extended north from Prince George to Fort St. John and Dawson Creek in the Peace River area. Not only did we have an interchange with the C.N.R. at Prince George, we now had a connection to the Northern Alberta Railway at Dawson Creek. It was on the Dawson Creek subdivision, the 61 mile leg which runs from Chetwynd to Dawson Creek, where the Railway utilized the first glu-laminated timber material in bridge construction in the fabrication of 150 ft. Timber Howe Truss. The bottom chord (tension) members of this truss were made of 4 pieces of $9'' \times 18''$ laminated Douglas Fir in lengths up to 70 ft. to reduce the number of chord splices. The remainder of the timber in the truss is all solid sawn forming the members acting in

compression. All this timber was pressure treated and the bridge is in good condition today, approximately 25 years in service.

In 1966 a short 23 mile portion of railway was built between Kennedy and Mackenzie to service the new mill town of Mackenzie that had been developed on Williston Lake. On this branch we utilized some of the first large glu-laminated bridge spans.

During this same period of time the railway was being extended from Odell (30 miles north of Prince George) to Fort St. James. Four timber bridges on this extension also utilized large glu-laminated spans in their construction in 1965 and 1966, with inauguration of this section of line in 1968.

Following this, the Fort Nelson Extension between Fort St. John and Fort Nelson (approximately 250 miles), was constructed with inauguration in September, 1971. On this line, glu-laminated spans were used on a number of major river crossings.

Up to this time we have been speaking of the railway as the Pacific Great Eastern. On April 1st, 1972, Premier W.A.C. Bennett, through order in council, renamed the railway the British Columbia Railway. Following the Fort Nelson Extension, work proceeded on the extension from Fort St. James towards Dease Lake, and again a large number of the bridge structures on this line utilized glu-laminated girder spans.

As a result of a rather complex set of circumstances involving political ramifications, etc., work on the Dease Lake extension was halted in April, 1977, where track has been laid a distance of 310 miles north of Odell.

In very recent years, attention has been focussed on the development of North East Coal, which now has involved us in the construction of a 130 kilometre (approximately 80 mile) branch line between Anzac and a new town of Tumbler Ridge in the North East sector of the province.

Development of the Use of Glu-Laminated Timber for Railway Bridges

In order to understand the development in the use of large glu-laminated timber spans for railway bridges, a short historical outline at this time will enable us to see the parallel in their use with the expansion of the British Columbia Railway.

In the early 1950's, Jan Wynand, Chief Engineer of Timber Preservers Ltd. (now Koppers International Canada Ltd.), developed designs utilizing glu-laminated timbers for small municipal bridges. Some of these were built and utilized in the lower mainland close to Vancouver, specifically in Haney.

In the years 1956 to 1958, Timber Preservers Ltd. made a concerted effort to interest B.C. Government in the use of glu-laminated spans in highway bridges. Jan Wynand developed a number of designs for highway bridges of H20-S16 loadings with composite timber and concrete deck and timber decks with asphalt surfaces. Spans of 30 feet to 100 feet were developed in 3 deck widths and a presentation was made to Mr. Gaglardi, Minister of Highways for the B.C. Provincial Government.

The lumber industry also became interested in furthering the use of glu-laminated timber and a book called Modern Timber Bridges was published. The B.C. Forest Service Construction Department also started using glu-laminated spans in the early 1960's on forest access roads and these are still being used for construction of forestry bridges today. Recently a 100 foot span was installed on the Similkamine River and also a new one at Tachie. The logging industry continues to use glu-laminated spans on their roads; Canadian Forest Products, Weldwood of Canada, B.C. Forest Products Ltd., Tahsis Lake Co., etc., to name a few. Some of these later logging spans have clear spans well in excess of 200 ft., utilizing underslung steel rod trussing.

With the development of glu-laminated spans in various areas for highway and logging bridges during the 1950's and '60s, it was a natural development to extend the concept to railway bridge construction in view of the rapid expansion of the Pacific Great Eastern Railway during these same years. Jan Wynand, Chief Engineer of Timber Preservers Ltd., contacted the Engineering Department of the P.G.E. Railway and discussed the advantages of using long span glu-laminated girders in bridge design and the possibility of their use in railway construction. Jan Wynand, working with our Bridge Engineer, Geof Parker, developed designs for a number of glu-laminated

spans from 30 ft. up to 140 ft. in length, using Coopers E-55 and E60 loadings and conforming to C.S.A. Specifications for Railway Bridges and allowable stresses for laminated coast Douglas Fir.

A number of factors influenced the use of these glu-laminated spans by the P.G.E. Railway:

1. Constructed from timber—a product of British Columbia's major resource industry.
2. Availability of material and speed with which the spans could be produced; this fit in with the speed by which the Railway extensions were developing and the need to supply bridge material on short order.
3. Costs of the glu-laminated timber spans in those years proved to be some two to three times less costly than for steel girder spans of similar lengths.
4. Handling and Installation
   Girders could be shipped over rough terrain without danger of distortion or damage.
   Spans could readily be assembled and erected by our own crews as well as by Contractors.
   Relatively simple equipment needed to handle.
5. Possible Field Alterations
   This aspect was not considered; however it proved to be an asset during construction of a bridge over the Chipmunk River on the Dease Lake Extension.
   Concrete piers and abutments had been constructed for a multiple span bridge at that location (Mile 309) over the Chipmunk River. The spans had been ordered prior to completion of the concrete work. During erection it was found that one of the longer centre spans could not be set in as centre to centre distance between piers was short by approximately 7 inches. After carefully checking the distance, the girders were shortened by cutting 3½ inches off each end.

In 1965 three glu-laminated spans were installed in the system. One 45 ft. span was used in the replacement of a timber trestle over Stone Creek south of Prince George. The replacement bridge was a pile and frame trestle with a 45 ft. glu-laminated span over the main creek. The second glu-laminated span was a 101 ft. span used as a replacement structure at Reynolds Creek which runs into the Parsnip River some 90 miles north of Prince George. Concrete piers were constructed within the existing old trestle. The glu-laminated span was assembled complete on temporary supports adjacent to the old trestle, and it was installed by moving it sideways on two sets of greased rails, pulling by means of a couple of B-B winches. (Slide presentation.)

The third span installed that same year was an 82 ft. 4 inch girder span over Merton Creek on the Odell to Fort St. James Line under construction in 1965.

The following year, 1966, the Mackenzie Industrial Lead was completed, and two timber bridges utilizing glu-laminated spans were built over the Misinchinka and Mischinsinlika Rivers. The same year, three more bridges on the Odell to Fort St. James Line were built over the Muskeg, Boundary and Salmon Rivers.

During the latter part of the 1960's, the extension of the Railway continued with construction on the Fort Nelson Line, 250 miles between Fort St. John and Fort Nelson. Glu-laminated girders were used in the construction of several bridges on this extension over the Blueberry, Gutah, and Fontas Rivers, as well as over Elleh Creek.

In 1972 a failure of the approach grade to the Blueberry Bridge occurred which seriously affected the south end of the bridge, which necessitated an extension of the bridge structure and re-design of the approach grade fill.

I have a series of slides of the failure and repairs to show you today, which emphasize the structural strength of the glu-laminated girder spans and their ability to withstand distortion and damage and their ability to be repaired and put back into service.

Following completion of the Fort Nelson Extension, work again proceeded on the Dease Lake Extension from Fort St. James northward. By the time work was halted on this extension in 1977, 37 bridges had been completed, including 32 structures utilizing glu-laminated girder spans.

With reference to the present construction on the Tumbler Ridge Branch Line into the North East Coal Fields, at least eleven more

bridges will be constructed. Design loadings established for this Line are Coopers E-80, and bridges are to be steel or pre-stressed concrete ballast deck structures.

This does not necessarily mean the end of our use of glu-laminated structures. If, for example, construction should commence on the Dease Lake Extension, it is very probable that glu-laminated spans would be utilized on some of the remaining stream crossings over the Duti, Kluatantan, Tsetia and Eaglenest Rivers.

As recently as three months ago, we replaced timber trestle approaches to a steel truss bridge with ballast deck approach spans, utilizing glu-laminated stringer spans, which decision was based on an economic analytical cost comparison with both steel and pre-stressed concrete spans. Although the cost of manufacture of glu-laminated timber spans in British Columbia has increased dramatically over the past few years, their use in selected circumstances will be expected to continue.

In closing, it was through an article in the July, 1981 issue of "Railway Track and Structures" describing our use of "Glu-Lam" bridge girders for the emergency repair of the B.C. Rail mainline near Pemberton, B.C., that initiated this presentation today, and at this point we will commence the slide presentation beginning with this particular emergency bridge washout and repair. In addition, I will show you slides of the installation of a glu-lam span on concrete piers replacing a timber trestle at Reynolds Creek; a number of slides of the failure of embankment and repair of the bridge over the Blueberry River, as well as a number of miscellaneous slides of typical glu-lam bridge spans.

Index of Miscellaneous Literature, Reports, etc.

Appendix "A"—B & B Master's Activity Report on Reconstruction of Rutherford Creek Bridge utilizing a 101 ft. Glu-Laminated Span.

Appendix "B"—"Modern Timber Logging Road Bridges". A Report by Koppers International Canada Ltd.

Appendix "C"—Summary of B.C. Railway Bridge Statistics.

Appendix "D"—Technical Data Sheet. One Type of Phenol-resorcinol Resin used in Laminating Douglas Fir.

Appendix "E"—System Route Map.

Acknowledgments

I. Koppers International of Canada Ltd.
II. Borden Chemical Western—Division of Borden Company Ltd.

APPENDIX A

SUBJECT: RECONSTRUCTION OF BRIDGE 89.65— RUTHERFORD CREEK

Attached please find activity report on the above.

The above job took 14 days, this includes the loading and transporting of materials at Prince George to bridge site.

It was not necessary to work double shifts or excessive overtime due to the fact that delivery of spans were not expected until January 9th. Also it was felt that to maintain safe work conditions we would not do any lifts unless it was daylight. Therefore only on Saturday, January 10th, did we set up portable light plants when we were on the ground putting on jewelry.

Activity Report for the Reconstruction of Bridge 89.7 Squamish Subdivision

Prepared by R. Sikorski, B & B Master at Prince George, B.C.—January 17th, 1981.

December 27th, 1980

Due to heavy rain fall Bridge 89.7 over Rutherford Creek was washed out. The south abutment became undermined and washed. The abutment cracked and crumbled in the river causing the 80′ deck plate girder to drop in the creek.

December 28th, 1980

Conference call—site to be inspected by Bridge Engineers to determine type of replacement and access damage.

December 30th, 1980

Bridge site was inspected on 29th.

It was decided to replace washout structure with a 101 foot Glulam span which originally was purchased for Duti Creek, Dease Lake Extension and which was stored in the Railyard, Prince George. To do this a south abutment and dumpwall would have to be built. An abutment constructed of timber and earth fill was decided upon, using timber salvaged from the Australian Bridge, also being stored in Prince George Railyard.

December 31st, 1980

Two highboys were loaded with 12′ × 12′ post material and 9″ × 18″ stringer material. This material left for N. Vancouver approximately 1700 hrs.

The 101′ Glulam was loaded in an open end gondola PGE 9224 with idlers on each end. Additional PGE 9129 loaded with accessories for Glulam span. Glulam was on departure track to be picked up and taken to CN at 1600 hours.

January 2nd, 1981

Two more highboys loaded with 70 pieces of 12″ × 12″ post material and sent to North Vancouver. CNR came and inspected load on departure track and more banding and lightening of cables was required. Outfit cars in Prince George were billed to Pemberton.

January 3rd, 1981

Bridge site was inspected by myself and Larry Griffin, B & B Supervisor. We also met with Cal Frost, Bridge Engineer. On site discussions were on following points:

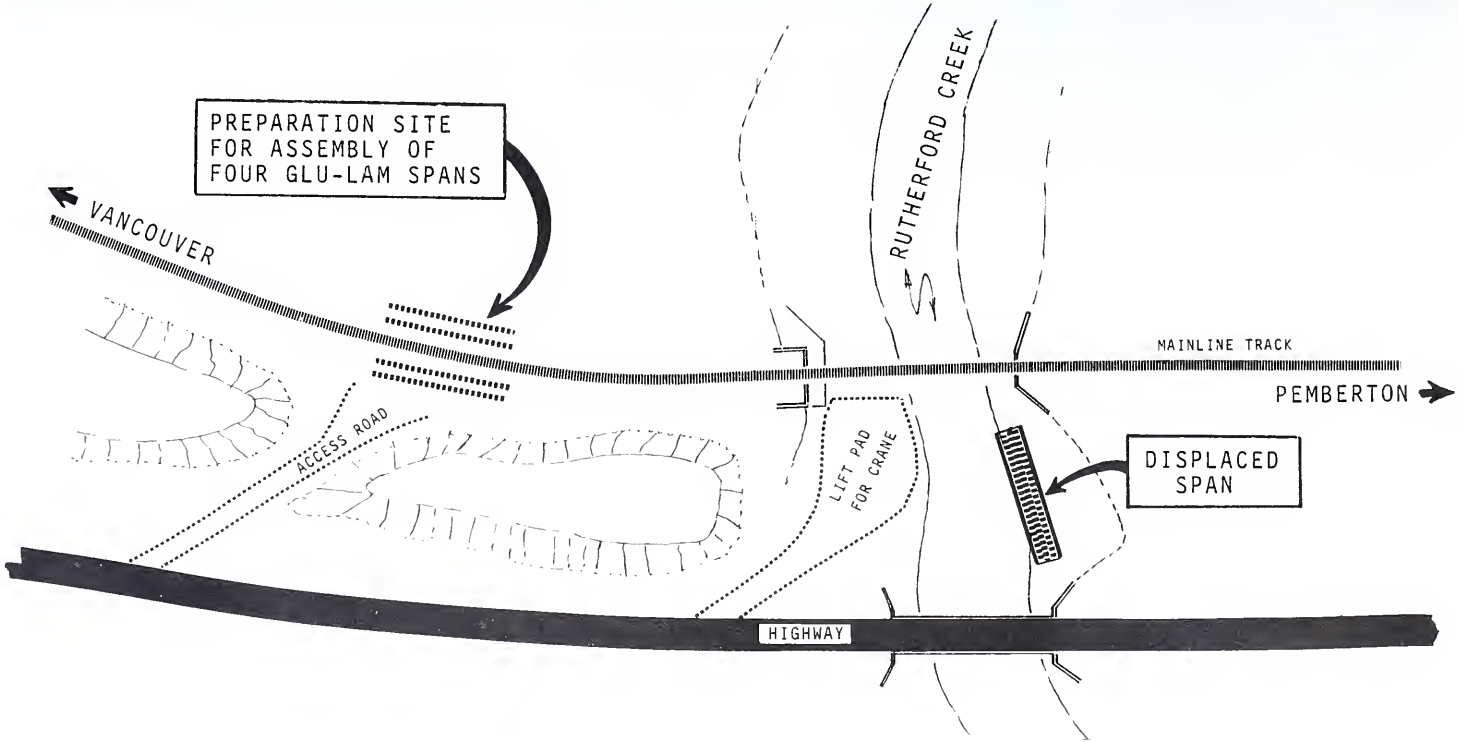
1. Equipment requirements
2. Men requirements
3. Tools
4. Site plan. (see attached sketch)

Highways required Borrow pit and an arrangement was made for highways to use material from joint right of way and in turn create an access road from the south end of the bridge site.

Equipment decided on:

1. Dozer D8
2. Backhoe ½ yard bucket
3. Mobile crane
4. American track crane
5. Bus for transporting men
6. Mobile tool house (use 5 ton van)

Accommodations secured at Pemberton Hotel until outfit cars are established at Pemberton.



RUTHERFORD CREEK BRIDGE REPAIR SITE PLAN
No Scale

January 5th, 1981

Loaded up tools from Gang 103 in 5 ton van and transported to bridge site. Lined up men required. Foreman from 105, 2 carpenters from 105, 2 carpenters from 168, Acting Foreman from 103, carpenter from 103 and Bridgeman from 103.

Dozer started making access and bed for mobile crane on river of Rutherford Creek.

Met with supervisor of Forsyth Equipment of Vancouver to discuss capacities of their 50 ton American Crane with retractable track. Decided we would use this crane and Cal Frost to arrange lease and loading on BCR flat cars.

First two trucks of timber arrived on bridge site and unloaded. Rail and ties over the washout were removed by cutting joint bars, rail and ties removed out of way. Backhoe preparing foundation for crib abutment.

January 6th, 1981

Last two trucks of timber arrived and were unloaded. Total material on site 119 pieces 12″ × 12″ × 21′ plus post material. 12 pieces of 9″ × 18″ × 30′ −0″ stringers all for construction of abutment and dump wall.

Crib or abutment construction started at approximately 1325. American Crane cannot arrive on site until January 7th, 1981. Therefore for construction of abutment a backhoe is being used. Attached please find a sketch of foundation and crib design.

January 7th, 1981

Work continuing on abutment with the backhoe assisting. Require final elevations first thing January 8th, 1981. South abutment at end of day—2 feet from completion. Bulldozer broke down at 1530. American Crane brought in by work train at 1130. American sorting out materials.

January 8th, 1981

Final elevation of bridge seats supplied by Brian Swinburne. Bridge seat complete at 1300. At 1300 start work on dumpwall. Brought in approximately 45 yards of gravel for final fill on dumpwall.

January 9th, 1981

Dumpwall completed at 1400 hours, south end. Work train arrived at 1230 hours with mobile crane and Glulam spans. At 1420 started preparing bridge seat, north abutment. Unload mobile crane and rig. Cat clear and level site for setting and unloading Glulam for January 10th, 1981.

January 10th, 1981

Unload Glulams. Unloading completed by 1230 hours and started preparing Glulams for jewelry. Glulams unloaded with mobile crane. Our American broke down at 1500, Brian Mohat and crane operator to repair tonight. Brought portable light plants on site to work after dark.

January 11th, 1981

Jewelry and blocks completed by 1300. Glulams are ready to place on bridge seats. Final preparation on north abutment raised 26¾″. Requested some section help in installing track to edge of south dump wall. Pick up 20 ties from Mile 92, reuse rail from washout. This rail will have to be removed and replaced at a later time due to it being bent. Track completed by 1700.

January 12th, 1981

Brian Swinburne came from North Vancouver to give final bridge seat elevations, some shims and adzing required. This was completed at 1300. Using rock jack and Rock Gang 153, anchor bolts drilled into concrete at north abutment. First Glulam in at 1525. Second span in at 1620, both spans blocked and secured. Days work completed at 1730.

January 13th, 1981

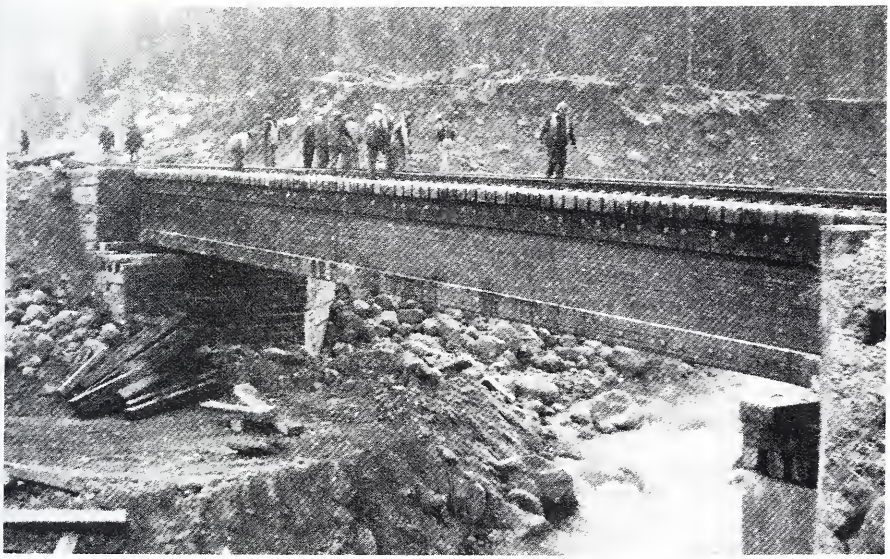
Bolted spans 1 and 2. Lift in #3 span at 1130 hours. Diaphragms installed and completed at 1430 hours. Lift in #4 span and tighten. Tightening not complete but will complete January 14th, 1981. D8 with ripper exchanged for small Terex because roadmaster required ripper.

January 14th, 1981

Tightening of spans #3 and #4 completed at 1015. Installed bridge ties and bolt down, complete and ready for rail at 1400 hours. Section arrived in morning and prepared north and south approaches. Dozer pushing material around abutment.

January 15th, 1981

Maintenance gang installing rail at north end, completed at 1400 hours. First train over bridge at 1542.



A 107-foot glue-laminated timber span was chosen to replace the steel structure at Pemberton, British Columbia

APPENDIX B

MODERN TIMBER LOGGING ROAD BRIDGES

Introduction

Timber bridges have been serving the needs of Canadian highway, logging road and railroad builders for generations. Modern timber bridges built today bear little resemblance to those which were originally used for crossings in earlier years although the basic structural material is the same.

Modern timber bridges are the result of technological progress within the laminating and pressure treating industries. The initial developments in improved designs in timber occurred on highway bridges and the same superior design concepts are applied to logging and railroad bridges.

The first glue-laminated logging road bridge was designed and built in 1956 as a crossing over the flood reservoir of Upper Campbell Lake on Vancouver Island. This bridge, over 210 m (690 feet) long consisted of pressure treated timber trestle approach spans, and multiple centre spans of glue-laminated girders 18–24 m (60–80 feet) in length. An important factor in the real value of this structure which is still in regular use, is the long, maintenance free service it has provided to the logging company owners.

Koppers International Canada Ltd. alone, has designed and supplied over 150 logging road, plus 250 other type bridges, and while the total number manufactured by the laminating industry as a whole is not recorded, one can conservatively estimate that there are more than 550 laminated wood bridges in service in Canada today.

Consideration as to the type of bridge to best fill the requirements of the forestry engineer will logically fall under the following headings:

DESIGN:

Logging road bridges differ considerably from those required for most highway crossings since the loadings are substantially heavier and generally only involve single lane traffic.

ECONOMY:

Maximum savings, with respect to structure, spans, supports, grade (movement of material) and the loading requirements, are mandatory.

DURABILITY:
Maximum service life, consistent with total investment to be made, considering the use of the bridge beyond the period of log-hauling is an important consideration. It should be noted that the longer the service life, the lower the annual cost of the structure.

VERSATILITY:
Changing traffic patterns and loadings may call for modifications to the structure, in addition to possibility of relocation with minimum inconvenience.

MAINTENANCE:
Complete freedom from maintenance means an increasing amount of road budget dollars available for new construction besides affording maximum dividends in safety and inspection costs.

In addition to the consideration given to the above factors, the forestry engineer will have in mind such requirements as speed of design and fabrication, once a decision to buy has been made, quick availability of materials, and above all, the reliability and experience of the supplier.

A MODERN TIMBER BRIDGE by KOPPERS INTERNATIONAL CANADA LTD. fulfills all of the above requirements, and, also of great importance to the forestry engineer, uses "wood"—Canada's most valuable renewable resource.

Design

To achieve maximum economy, logging road bridges are designed to suit the specific needs and load conditions of logging truck traffic.

Deck Structure

Deck widths are preferably limited to 4.25 m (14 feet) inside the wheelguards for three reasons:
—to assure a maximum of only 0.46 m (18 inches) "off centre-line" driving. This restriction results in a more economical design due to a better load distribution on the supporting girders on each side.
—to concentrate wheel loadings over the girders and to eliminate the necessity for a girder on the centre line of the bridge.
—to minimize the size of cross-ties required.

Designs can be modified to suit 4.90 m (16 feet) or wider deck widths when necessary.

Load Conditions

Unbalanced load conditions of logs on the trucks can be dealt with effectively by known gross wheel load distributions for worst cases.
—actual weigh scale results recorded for five logging truck loads by a Western Canadian Forest Products company indicates a maximum gross load distribution of 65% on the wheels on one side to 35% on the wheels on the other side. On the basis of these results the design engineers within the industry agreed to use this distribution as typical for all logging road bridge designs.

This typical load distribution is also used by Government Forest Service Departments.

Koppers Design Standards

Koppers International Canada Ltd. has developed standards for the design of single or multiple span logging road bridges which are based on the foregoing factors.

In summary, these standards are:
1. For lighter loadings two single girders are spaced at 3.00 m (10 feet o.c.). Diaphragms and tie-rods are placed between at approximately 7.50 m (25 feet) centres along the span.
2. 8″×12″ cross ties on edge @ 0.40 m (16″) o.c. form the basic deck structure. Pairs of ties @ 0.80 m (2′-8″) o.c. are fastened down to the girders @ 3.25m (10′-8″) o.c. and the remaining ties are held in place by the plank decking.
3. Longitudinal running planks are nailed to every cross tie across the full road width.
4. For heavier loadings the girders are placed in pairs on each side with spacer blocks between. The pairs of girders are tied together with rods and diaphragms.

To ensure permanence, all structural ood members are pressure treated with eosote solution and all connection hard- are is galvanized. The longitudinal plank ck performs two important structural nctions, namely:

a) to support and distribute wheel loads, and
b) to provide lateral stiffness against sway and wind forces.

There are two different decking systems mmonly used. One method is to use 4 inch ıtreated planks as a combination of struc- ral deck and wearing surface. Since this pe of deck is subject to mechanical wear ıd damage it requires fairly frequent placement resulting in damage to the sup- rting crossties. It is therefore more prac- al to use untreated ties with this deck stem.

The alternative, and most recommended ck system consists of treated crossties sup- rting a 3 or 4 inch treated plank deck, with or 3 inch untreated planks nailed to it for wearing surface. In this case smaller nails n be used and replacement costs due to ar are much lower.

Frequently, due to location or for other asons, logging road bridges may need to of longer spans than can be achieved by ngle girders. Such spans can easily be complished by using cable-suspended or uss supported girders of suitable length, ıd splicing or abutting them to obtain the quired span length. In most cases, the rders for these types of bridges are signifi- ntly shallower in depth and splicing pro- des for easier handling and shipping.

iers and Abutments

The types of piers or bents most com- only used are of concrete, timber or tim- r piles. Concrete bents are generally most onomical and practical for bridges where er heights are not excessive and where gregates are readily available. On the her hand, sawn timber or pile bents are ry practical for relatively low bent heights ıd smaller load reactions. However, it has en found that, in the case of higher piers, laminated timber bent is a very practical ıd economical solution to pier construc- n. These bents have the advantage of inimizing the amount of concrete required. Laminated timbers of relatively large size permit a simple, double leg design and the entire tower can be completely prefabricated and assembled readily in the field.

Supported by simple piling, sawn timber bents or sometimes by more elaborate bent structures, multiple span laminated girder bridges give maximum service at low initial cost and are virtually maintenance free. Vertical clearance above high water and flood debris is greater than that of a truss supported deck.

Abutment construction also offers an opportunity to effect design economies. In many cases it has been found most economical to support long span, deep girders on low cost piers, instead of on costly, high, concrete abutments with long wing walls. Short approach spans can then be added at each end. These latter spans are supported in a notch on the main span girders at one end and on a low cost timber pile bent with plank bulkhead at the other end.

By careful study and investigation at the initial stages the designer can find the most desirable combination of piers and spans to yield the most economic, in-place, total crossing cost. Koppers International Canada Ltd. will provide current pricing for the designer to assist in comparative studies.

Economy

While a consideration of the economies of various types of structural materials to be used for bridges is important to the designer, he must also look for plus factors in each of the different types of materials. Specifying the use of glued laminated timber will, in most cases result in an overall reduced cost to the project.

The most economical type of bridge to use is multiple spans of up to 60 feet where short piers can easily be installed. Alternatively, where pier construction is limited, combinations of long centre spans and short approach spans are practical.

Modern timber bridges provide bonus features which contribute to the basic economies of a crossing design.

1. Minimum on-site concrete cost.
2. Minimum time requirement for design and supply of materials required.
3. Lower transportation and handling cost.

4. Faster assembly and erection as a result of complete prefabrication and the material can be handled easily in extreme weather conditions. Girders may be preassembled at the plant to reduce on-site labour costs.
5. Timber permits the maximum use of semi-skilled labour and allows for a maximum of plant fabrication. Connections are relatively simple.
6. KICL laminated plants in both Western and Eastern Canada are fully experienced in all phases of manufacture of bridge components and have the finest of engineering facilities available to them.

The foregoing factors contribute to cost reductions and combined with the possible use of the owners equipment and construction crews for erection should be given serious consideration by the designer before making a decision in respect to the final design of the crossing.

Durability

The laminating industry's progress in engineering and technical research into the physical properties of wood has resulted in designs which provide maximum service life. Pressure treatment with creosote oil preservative for total protection—refinement of sawn timber design—glued laminated fabrication permitting new shapes and sizes of structural members—all these are combined in modern timber bridges.

Timber construction has added advantages—

1. Temperature and weather stability. Expansion and contraction or changes due to temperature differentials are negligible and are not usually a consideration in design.
2. Great impact strength to withstand overloads for short periods of time.
3. The ability to accept pressure treatment with known and effective preservatives to provide permanence to the structure.

These factors not only contribute to savings in design and construction costs but also provide the desired permanence in the structure. Modern timber logging road bridges erected over two decades ago still show no visible signs of deterioration.

Versatility

In addition to the flexibility in design concepts, modern timber logging road bridges offer greater versatility in service.

Competitive initial cost combined with minimum maintenance during service life is not the only advantage. Modern timber logging road bridges are easily dismantled, salvaged and relocated. They can be easily modified to provide for future load increases or for grade adjustments at a minimum of cost and interruption of service.

The sizes obtainable and thereby the strength capability of glue-laminated girders makes it possible to design single spans that carry loads of up to 365 tonnes (400 tons). Multiple spans up to 175 m (575 feet) and clear spans of up to 63 m (205 feet) are now in service.

Maintenance Free

The true measure of a materials value in construction is its ultimate cost; which is the sum total of initial materials and construction costs combined with maintenance and/or replacement cost, averaged throughout the service life of the structure.

Preservative treatment of structural components inhibits decay and deterioration, eliminates the need for painting and reduces maintenance. There is ample evidence to attest to the superiority of modern timber logging road bridges from the point of view of maintenance cost. There are spans in service now that were installed over 20 years ago and need no painting and have required no maintenance other than replacement of running planks during this period of service.

Designed to obtain maximum economy, with long maintenance free durability in service, the versatile modern timber logging road bridges is in common use by most forest products companies in Western Canada. In view of the foregoing facts this type of bridge should receive prime consideration at the design stage.

ummary

It is the purpose of Koppers International
inada Ltd. to serve the needs of their
otential bridge customers. When cost fac-
rs and all economic considerations are
sentially the same, the ultimate design may
based on two things of greatest concern
the user, that is: *performance* and *benefits*
any given material.
In the case of laminated timber bridges
rformance is assured.
Structurally, the material has the capa-
lity of carrying the loads.

1. It has the bonus advantage of tempera-
ture and weather stability. Expansion
and contraction or changes due to
temperature differentials are not of
serious consideration.
2. The material can be handled and
erected easily in extreme weather
conditions.
3. Timber has the added advantage of a
great impact strength and can with-
stand severe overloads for short peri-
ods of time.
4. Pressure treatment with known and
effective preservatives provide perma-
nence to the structure.

The *benefits* to be derived from use of glued laminated timber bridges can be summarized as follows:

1. Competitive initial cost with a poten-
tial for savings which may result in the
lowest erected cost.
2. Availability of a complete prefabri-
cated bridge on relatively short notice.
3. Minimum maintenance during its life-
time with the added advantages of
being easily dismantled, salvaged and
relocated.
4. Laminated timber bridges can be easily
modified to provide for future load
increases or for grade adjustments, at
a minimum of cost and interruption of
service.

APPENDIX C

SUMMARY OF B. C. RAILWAY BRIDGE STATISTICS

igust 1982

the present time our Bridge Statistics
e as follows:

rth Vancouver to Lillooet
cluding Port Sub)
12 - Timber pile trestles or single timber spans
2 - Steel bridges with timber approach spans
2 - Bridges utilizing glu-laminated spans
61 - Steel bridges or pre-stressed concrete ballast deck bridges
77 Total

Lillooet to Prince George
6 - Pile and timber trestles
1 - 45 ft. Glu-laminated span with timber trestle approaches
1 - 5 span glu-laminated girders on concrete
19 - Steel bridges on pre-stressed concrete ballast deck bridges
27 Total

(3) *Prince George North to Fort Nelson Inc. Mackenzie Ind. Lead and Dawson Creek Sub*
4 - Pile Trestles
4 - Steel bridges with timber approaches
8 - Glu-laminated span bridges
1 - Timber Howe Truss with laminated bottom chord members
33 - Steel bridges or pre-stressed concrete ballast deck bridges
42 Total

(4) Dease Lake Extension - (from Odell North)
2 - Steel truss bridges
3 - Timber pile trestles
32 - Glu-laminated structures
(Some are multiple spans and some single spans with timber trestle approaches)
37 Total
A total of 183 bridge structures on the entire system.

APPENDIX D

LAMINATING DOUGLAS FIR WITH CASCOPHEN 3400—CATALYST 4675 ADHESIVE

CASCOPHEN 3400—Catalyst 4675 is a modified phenol-resorcinol resin adhesive for use in the wood laminating industry. The resin and catalyst-extender combine to form a high quality, low odor exterior resin adhesive which meets Federal Specifications for intermediate temperature (35°C–88°C) curing adhesives for wood laminating. This adhesive requires a minimum glue line temperature of 32°C for cure.

CASCOPHEN 3400—Catalyst 4675 is certified by Borden Chemical Western to have passed the required tests stipulated in the following standard:

Canadian Standards Association Specification for Phenol and Resorcinol Resin Adhesives for Wood, C.S.A. 0112.7-1960 (Type II).

Properties

CASCOPHEN 3400 is a dark red, viscous liquid having the following physical characteristics:

Solids (by weight)	54%
Specific Gravity at 25°C	1.118
Weight kg/l	1.13
lbs/Imp Gallon	11.2
pH of Liquid Resin	8.5
Viscosity at 25°C	200 cps

Catalyst 4675, the catalyst extender used with CASCOPHEN 3400, is a light brown powder with a slight formaldehyde odor. Catalyst 4675 contains paraformaldehyde.

Storage Life

CASCOPHEN 3400 resin has a storage life of 6 months at a temperature of 25°C. This storage life will be materially affected by changes in temperature. In a cool area or under refrigeration the resin life is extended; if stored in a warm area, resin life is shortened, i.e., at 35°C, resin life is 2½ months.

Catalyst 4675 extender should be stored in a cool dry area in a tightly closed container. The catalyst extender has a storage life of 6 months under these conditions.

Mixing Instructions

A mechanical mixer is recommended for mixing this adhesive. Following is the ratio of resin to catalyst extender and mix time:

CASCOPHEN 3400 Resin	5 parts by weight
Catalyst 4675 Extender	1 part by weight

Mix 5 minutes (or until smooth)

Catalyst 4675 extender is added to CASCOPHEN 3400 resin with agitation and mixed until smooth and well blended. All mixing and spreading equipment should be free from traces of acids, alkalies, or glue residue.

Working Life and Pot Life

"Working life" is the maximum time a glue mix can be used safely with the assembly times given in this bulletin. Workable assembly times are reduced rapidly beyond the working life period.

"Pot life" is the maximum time a glue mix can be held in a liquid state. The glue begins to harden at the end of this time and, if not removed from the storage container, soon becomes solid.

Both working life and pot life are dependent upon the temperature of the mixed glue as given below:

Temperature of Mixed Adhesive	Working Life	Pot Life
10°C	16 hours	21 hours
16°C	8½ hours	10 hours
21°C	5½ hours	6½ hours
27°C	2½ hours	3½ hours

No more glue should be mixed than can be used during the working life. Freshly mixed glue may be added to a previously mixed batch in the spreader pot providing that the quantity of previously mixed glue does not exceed 10% of the pot capacity and has not exceeded 2/3 of its working life.

Condition of Wood

The wood surfaces should be clean, freshly prepared, carefully fitted, and planed smooth with a maximum of planing marks per inch. Lumber moisture should not exceed 16% and for optimum bond quality, should be 8–12%.

Spreading

The recommended spread range for this adhesive is 342–490 g/m^2 (70–100 pounds per 1,000 square feet) of joint area. Spread weights as low as 293 g/m^2/sgl may be satisfactory under certain layup conditions. However, before using spreads below the recommended 342–490 g/m^2 spread range, our representative should be consulted concerning the allowable conditions.

Assembly Time

The following table of maximum allowable assembly times is given for lumber temperatures from 4°C to 30°C. Gluing lumber with temperatures above or below this range is not recommended because of adverse assembly time and cure conditions at either very low or high lumber temperatures.

MAXIMUM TOTAL ASSEMBLY TIME FOR
415 g/m^2/sgl (85 lbs/Msgl SPREAD (MIN))

Lumber Temperature	Relative Humidity			
	Less than 50% Average Lumber Moisture Content		Greater than 50% Average Lumber Moisture Content	
	Less than 8%	9–16%	Less than 8%	9–16%
4–9°C	120	120	120	120
10–15°C	120	120	120	120
16–18°C	120	120	120	120
19–20°C	110	120	120	120
21–23°C	90	105	100	110
24–26°C	65	80	70	90
27–30°C	45	60	45	65

The maximum open assembly time should not exceed one-third of the maximum total assembly time.

To develop optimum bond strength, the following conditions are recommended:

Lumber Temperature	21–25°C
Lumber Moisture	9–12%
Open Assembly Time	0–10 minutes
Closed Assembly Time	40–50 minutes
Total Assembly Time	40–60 minutes
Spread	415 g/m^2 (85 lbs/Msgl)

Pressure

Pressures of 690–1034 kPa (100–150 psi) are recommended for Douglas fir. In all cases, the assembly conditions and clamping pressure should produce a uniform squeeze-out the entire length of the glue line.

Curing

For general assembly gluing, the following table shows minimum clamp time at given inner glue line temperatures. Curing temperatures below 32°C should not be used.

Inner Glue Line Temperatures	Clamp Time
32–35°C	4 hours
36–38°C	3 hours
39–43°C	2 hours
44–49°C	1¾ hours
50°C and above	1½ hours

Laminated arches or other members where stress is imparted to the package should be clamped 50% longer than the minimum times given in the above table. This added clamp time will minimize effects resulting from "springback" at the time of unclamping.

Cleaning

Equipment

Normally hot water or steam and hot water will clean off the adhesive. If the adhesive is old and starting to set up, a dilute caustic solution should be used. All equipment must be thoroughly rinsed with water after using a caustic solution.

Hands

Workers having occasion to get CASCOPHEN 3400—Catalyst 4675 on their hands should wear rubber gloves or wash the glue off before it dries. Use 20% alcohol or acetone solutions to wash off the glue and rinse in warm water. Wash thoroughly with soap and water after rinsing.

Clothing

When using CASCOPHEN 3400—Catalyst 4675, it is advisable to wear old clothing or aprons which can be discarded. Once the glue has set, it cannot be removed from clothing.

Precautions for Proper Use

The preceding recommendations for stock conditions, assembly times, cure times and temperatures should be followed closely for best results. Specific problems of application not covered here should be referred to a technical representative of Borden Chemical Western.

President Hyma: Thank you Mr. Frost. That is a very appropriate use of glulam in your part of the country. This Association thanks you and the British Columbia Railway.

This brings us to our first special subject committee report. Mr. A. S. Uppal who is a director and the sponsor of this special subject committee would normally introduce his chairman. Unfortunately, Mr. Uppal had an accident and has his leg in a cast so is unable to be with us. The introduction will be made by Mr. Jim Williams, Junior Vice President and Chairman of Special Subjects. Jim.

Mr. Williams: Mr. President, members and guests. Mr. A. Shakoor Uppal is the sponsor for this special subject. Since Mr. Uppal's leg is in a cast and is unable to attend the conference, it is my pleasure to introduce the chairman for Special Subject No. 3, Maintenance and Replacement of Bridge Bearings, Mr. Steve Lipkus.

Mr. Lipkus graduated from McGill University in 1977. Immediately thereafter he began work for CN Railways. He has five years' experience in bridge and building design and presently he is Engineer, Planning and Inspection on the St. Lawrence Region based in Montreal where he is engaged in coordinating bridge, culvert and building inspections.

His first interest in bridge bearings derives primarily from design of bearings and secondly from the inspection of bridges. He is presently nearing the completion of his masters degree in structures. I present Mr. Steve Lipkus.

Maintenance and Replacement of Bridge Bearings

Chairman: S. Lipkus, Design Engineer, CN Rail, Montreal, Canada
Vice Chairman: D.K. Franz, Bridge Insp., Milwaukee Road, Chicago, Il
Committee: B.T. Burns, Steel Bridge Insp., ATSF, Topeka, Ks
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G.D. Spencer, President, Spencer Dynamics, Providence, RI
N.A. Smith, Str. Designer, MP, St. Louis, Mo
W.J. Gunkle, Sr. Str. Insp., Conrail, Philadelphia, Pa
J.S. Partilla, Asst. Supvr. & Insp. B.&B., Union, Duquesne, Pa

* * *

(1) FUNCTION OF BRIDGE BEARINGS

Bridge bearings are required to safely transfer all loads from the superstructure to the supporting substructure. They must fulfill two basic requirements:

(a) They must spread the reactions over adequate areas of the substructure; and

(b) They must be capable of responding to the following without generating harmful restraining forces:
  (1) Longitudinal and transverse rotations of the ends of spans.
  (2) Thermal movements (expansion and contraction); and
  (3) Any movements of the substructure. (e.g. foundation settlement, etc.)

In order to accommodate these force effects, expansion bearings are required to allow movements in the span to take place. To control the movements, at least one set of fixed bearings is required in each simple or continuous span.

Bridge bearings are also required:
(1) To prevent lateral span movements
(2) To prevent uplifting of spans
(3) To provide anchorage against flood, ice effects or collision.

(2) TYPES OF BEARINGS

Bearings can broadly be defined into two groups, namely metal bearings and elastomeric bearings.

(a) Metal Bearings
These are generally made of structural steel, cast steel or cast iron. Their basic components are (See Figure 1):
  (1) An upper unit (sole plate or shoe plate) which is connected to the superstructure.
  (2) A lower unit (bed plate, masonry plate, base plate, or pedestal) which is anchored to the substructure.
  (3) If required (depending on length of span), intermediate elements for centering and for adapting to rotational movements, and in the case of expansion bearings for accommodating longitudinal movements of the superstructure.

There are essentially three types of metal bearings; plate type (i.e. flat or sliding), rocker or disk type, and rolling type.

(i) Plate Type Bearings
For very short spans with light

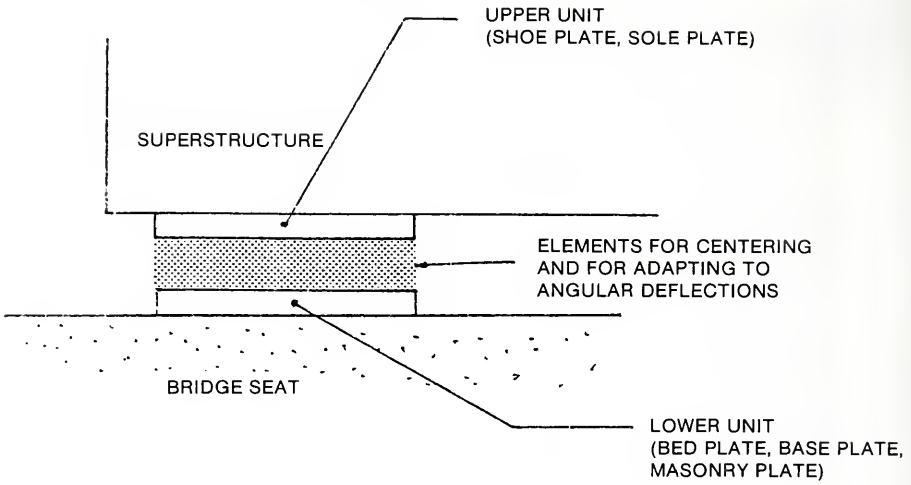

FIGURE 1—Steel bearing components

reactions, flat plates can be used for both fixed and expansion bearings. Because the end rotation and expansion of these spans is extremely small, slotted holes at one end are sufficient to accommodate longitudinal span movements.

For short spans up to 50 ft. in length, sliding plates are used at the expansion end. These usually consist of two flat steel plates in contact with each other which may or may not be lubricated.

They are sometimes provided with bronze or other low-friction sliding surfaces. The plates may also be manufactured with a rectangular tongue and groove to restrict lateral span movements. Examples of plate bearings are shown in Figure 2.

The main concern with this type of bearing is that because they do not accommodate span rotations, excessive bearing pressures may develop under the masonry plate which can lead to deterioration of the bridge seat. In addition, sliding lubricated plates tend to collect dirt and seize. Non-lubricated sliding plates have a greater frictional resistance, making it necessary for longitudinal-span forces to overcome sliding friction before movement can take place.

Of course the main advantage of using flat-plate or sliding-plate bearings is that they are much less expensive than other bearings.

(ii) Rocker and disc-bearings

Rocking-type bearings make use of a curved segment placed between the sole plate and the masonry plate. This curved segment may have a cylindrical or a spherical shape and can bear on either a flat plate or a matching shaped plate.

Rocker bearings are expansion bearings, accommodating span movements through rocking action (See Figure 3). They are usually held in place by pintles shaped like gear teeth. For longer spans (greater than 70 ft.) hinges or pins are provided for rotation.

Disc bearings are designed to permit rotation of the span at both the fixed and expansion ends (See Figure 4). Slotted holes at the expansion end allow the bearing to slide on some low-friction surface to permit thermal movements.

Both rocker and disc bearings often use bronze alloy, or sintered metal plates containing inserts of special graphite lubrication com-

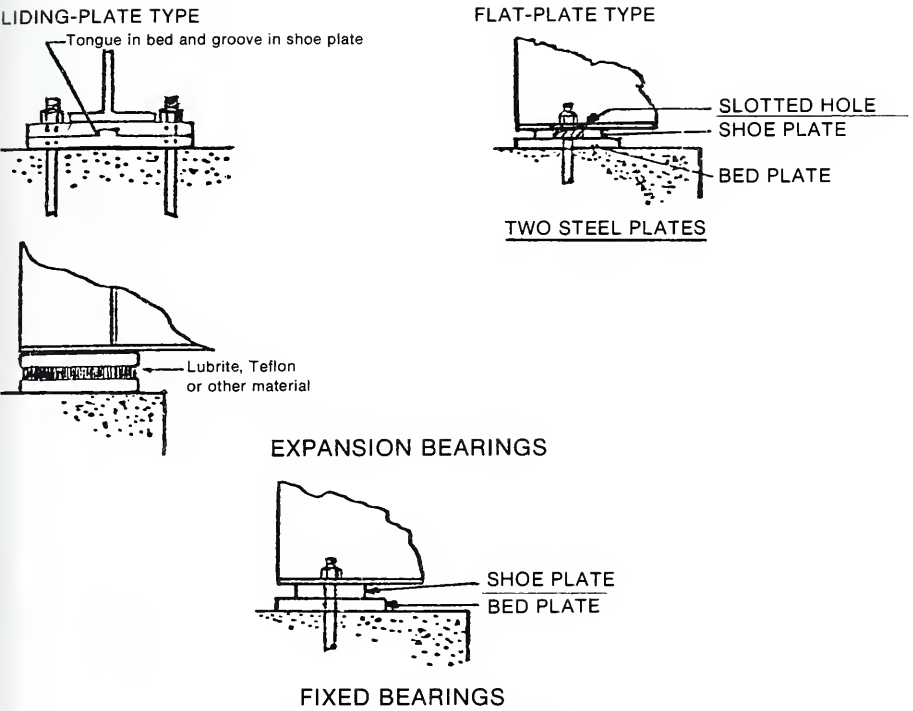

FIGURE 2—Plate type bearings

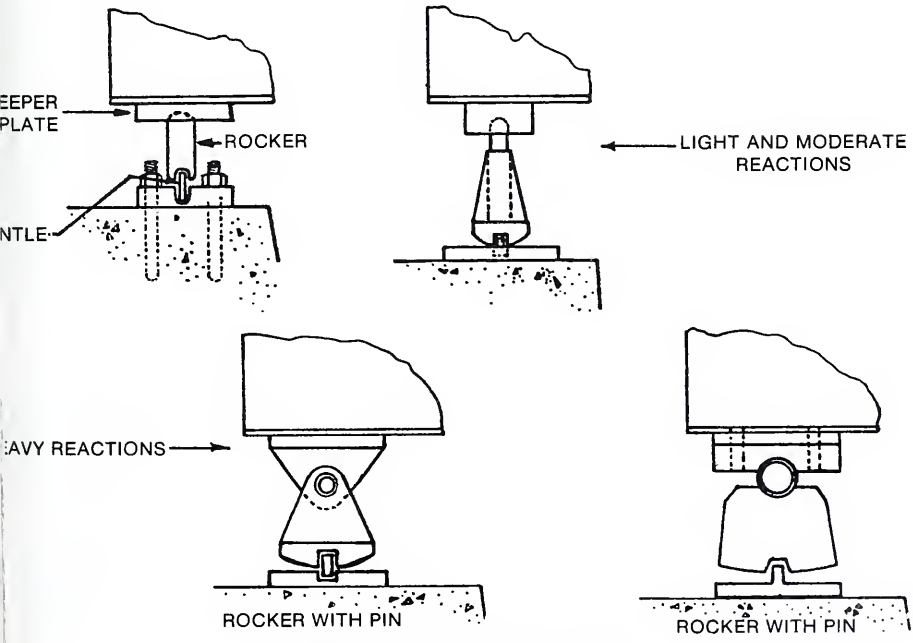

FIGURE 3—Rocker type bearings

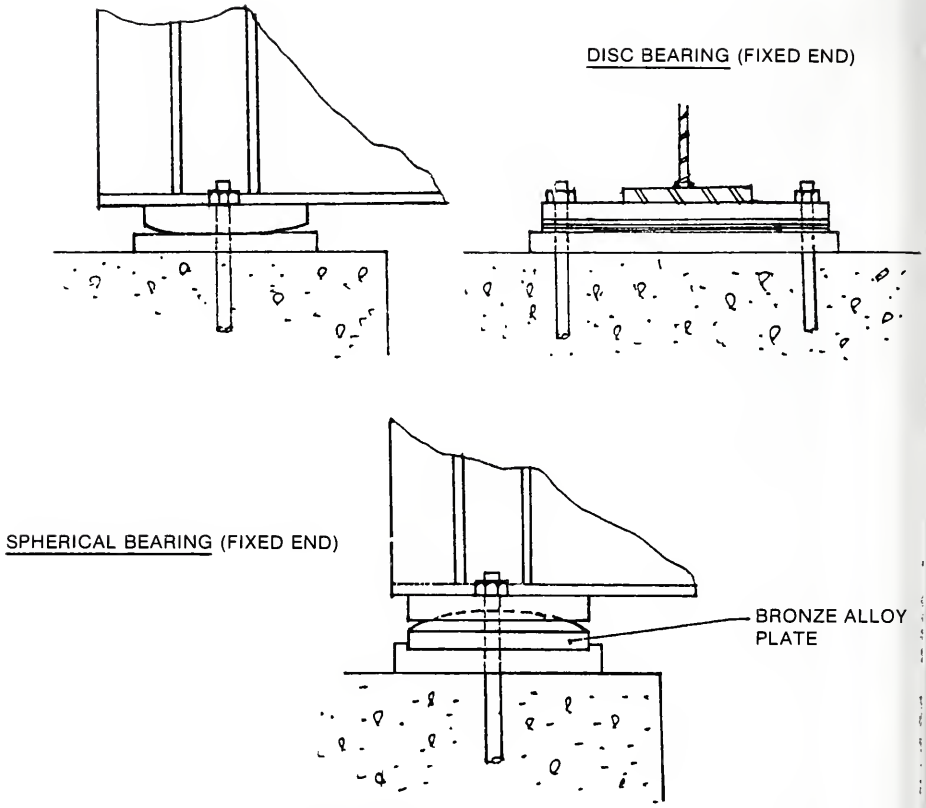

FIGURE 4—Disc type bearings

pound to reduce rotational friction. A material called PTFE (polytetrafloro ethylene) more commonly known by its trade name "Teflon," is often used to provide a low-friction surface for exansion.

Because rocking-type bearings are mechanically simple, they require less maintenance than roller bearings. It is important, however, to make sure that lubricated types do not run out of lubricant. The shapes of some rocker bearings are such that dirt may accumulate on the masonry plate causing resistance to span movement.

(iii) Roller-type bearings

Because the necessary radius and size of a given rocker-bearing depends on the load that must be supported, for a very heavy reaction the size of the bearing may be too large to be practical. This problem is solved by using a series of rollers which may be either segmental or cylindrical in shape (see Figure 5). Segmental rollers are used when the diameter of cylindrical roller required by design is too large.

Rollers are often held together with side bars and the entire nest held in position by cams which engage slots provided in the shoe plate and bearing plate.

Side bars may be omitted if each roller is held in place with tooth guides. The entire roller assembly is sometimes enclosed with removable dust guards.

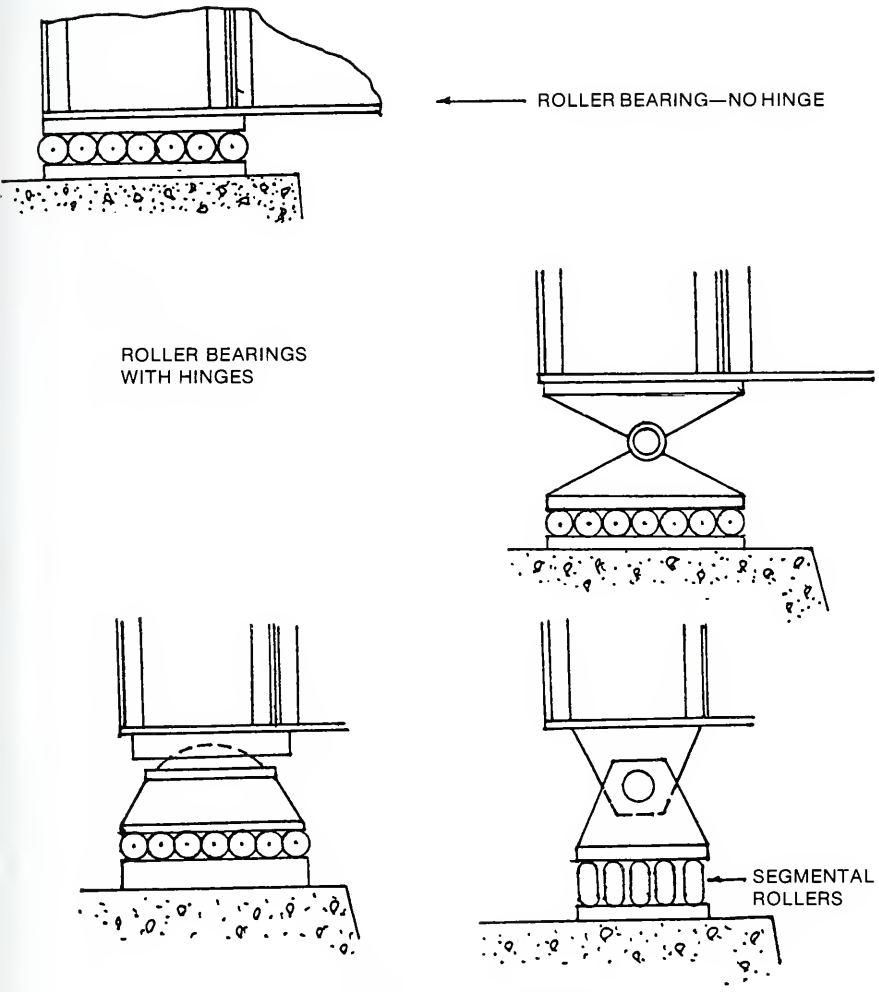

FIGURE 5—Roller bearings

Of the various types of metal bearings, roller bearings are by far the most expensive and troublesome. They are generally used on spans greater than 150 ft. The most common problem associated with them is corrosion. Dirt and moisture tend to collect between rollers causing the bearings to seize.

Other common problems are:

(a) Side bars sometimes break off allowing the rollers to shift.

(b) Rollers can develop flat spots, causing a corrugated wearing of the bearing plates.

(c) Segmental rollers can tip and fall out of place.

Since roller bearings are used on long spans, very harmful thermal restraining forces can be generated. Rollers are often greased to reduce friction and prevent corrosion, although care should be taken to use a grease which does not readily attract dirt.

(b) Elastomeric Bearings

There are several different types of elastomeric bearings. The main

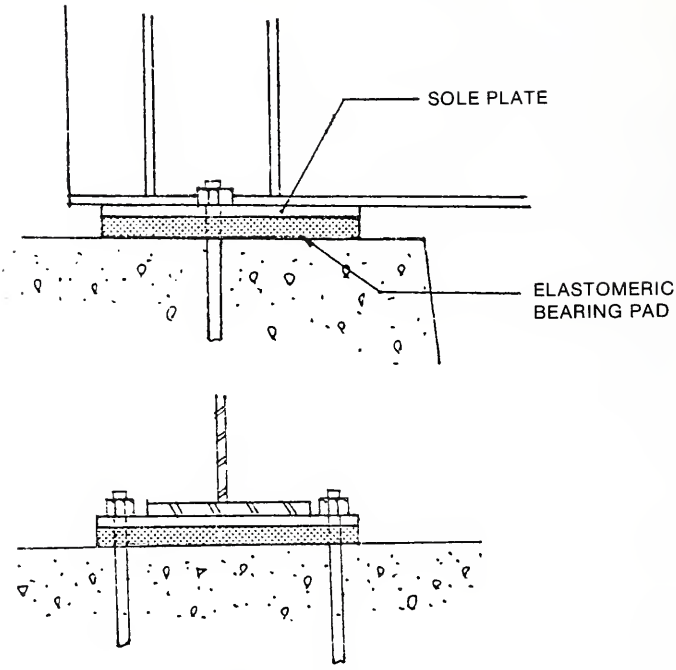

FIGURE 6—Plain bearing pad

component that is common to all of them is an elastomer material made from either natural rubber (polyisoprene) or synthetic rubber (chloroprene, neoprene, etc.). The function of the elastomer varies for each type of bearing. The most common types are as follows:

(1) Plain bearing pad
(2) Laminated bearing pad
(3) Sliding bearing pad
(4) Confined pot type
(5) Unconfined elastomeric disc

In general, the main advantage of elastomeric bearings is that they do not corrode and therefore do not seize. In addition, they provide a means of damping span vibrations which often lead to deterioration of the bridge seat. Although their properties change with temperature, this problem is generally overcome by ordering a bearing with suitable properties within the required design temperature range.

Possibly the greatest problem encountered with elastomeric bearings concerns materials which do not meet specified requirements. Defective signs could be cracking, splitting, excessive bulging, or tearing of the elastomer. Improper fabrication can result in the top and bottom surfaces of elastomeric pads not being parallel, which could result in uneven bearing pressures on the bearing or the bridge seat.

(1) Plain Bearing Pads

Plain bearings made of elastomer only have been used on short spans with light reactions (see Figure 6). The nature of the material is such that although it compresses very little under vertical load, it can deform horizontally, allowing longitudinal movements and small rotations at the ends of the span to occur.

One advantage in using plain bearings is that under compressive loading the pad "absorbs"

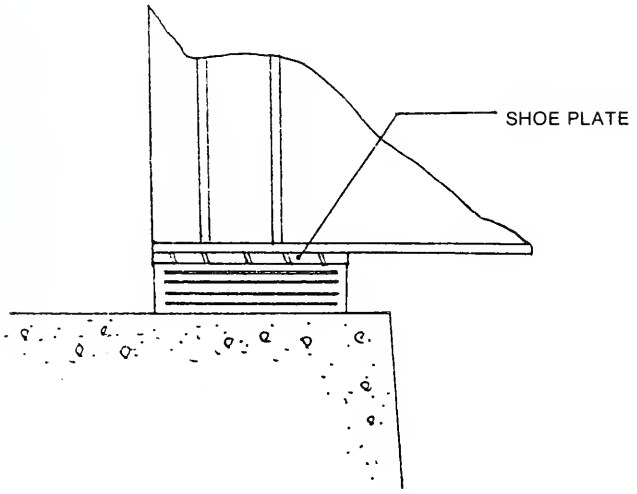

FIGURE 7—Laminated bearing pad

surface irregularities. In this way all of the contact surface area carries the load. In addition, this type of bearing does not need to be lubricated or cleaned.

One problem associated with these bearings is that they tend to "creep" horizontally if not properly attached to the bridge seat or span.

(2) Laminated Bearing Pad

For large spans where greater thermal movements occur, a bearing constructed with layers of steel plates moulded within the elastomer to provide reinforcement may be used (see Figure 7). As with plain bearings, longitudinal span movements are accommodated by shearing deformation. Some laminated bearings are constructed with the layers of steel exposed at the edges and have been known to give field problems due to separation of layers.

(3) Sliding Bearing Pads

This type of bearing consists of a top steel plate with a highly polished stainless steel lower surface which slides on a bottom laminated elastomeric bearing pad with a Teflon upper surface (see Figure 8). The principal advantage of this is that the sliding action can accommodate large longitudinal movements of the span while keeping the thickness of the elastometic pad to a minimum.

As with sliding-plate metal bearings, care must be taken to ensure that dirt does not collect on the sliding surface. If horizontal forces are transferred to the bearing pad, possible damage may result.

(4) Confined pot bearings

For long spans with heavy reactions, confined-pot bearings can be used (See Figure 9). Being confined, the elastomer within the pot behaves like a fluid to accommodate rotation. This is extremely useful when the bearing must rotate in more than one direction as is the case in skewed bridges. At the expansion end the bearing assembly is seated on a steel plate with Teflon placed in between

FIGURE 8 SLIDING BEARING PAD

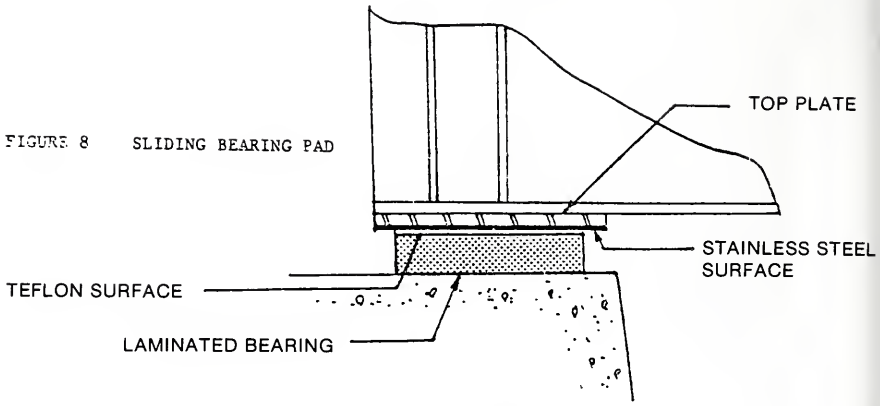

FIGURE 8—Sliding bearing pad

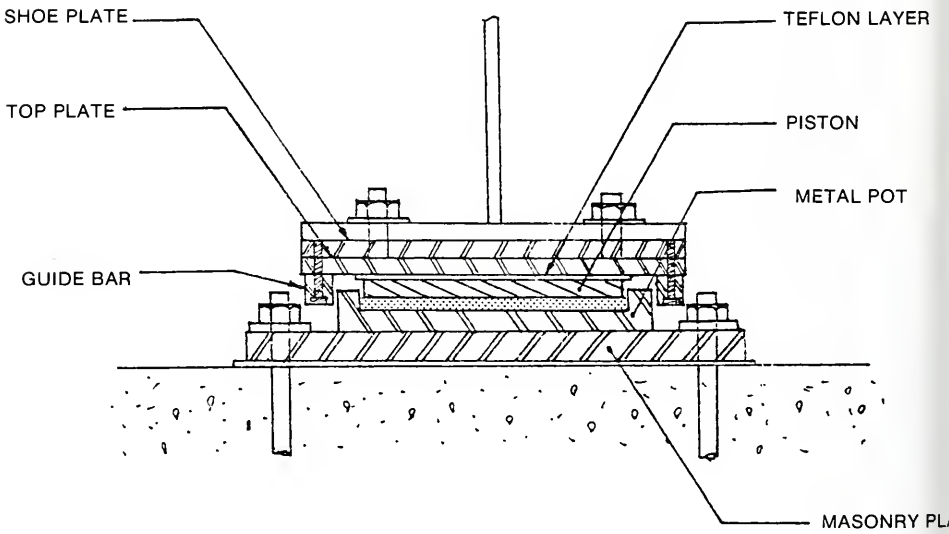

FIGURE 9—Confined pot bearing (expansion type)

to allow sliding thermal movements to take place. Guide bars are used to restrain any transverse movement of the span.

(5) Unconfined elastomeric disc

This type of bearing is similar to the confined pot bearing except that the elastomeric bearing material is not confined within a pot (see Figure 10). A pin-dowel device is used to prevent any horizontal creeping of the elastomer. One advantage that this bearing has over the confined-pot type is that it can be easily inspected. Although the elastomer is supposed to be practically chemically inert and not subject to ozone oxidation or other long-term weathering or bacterial

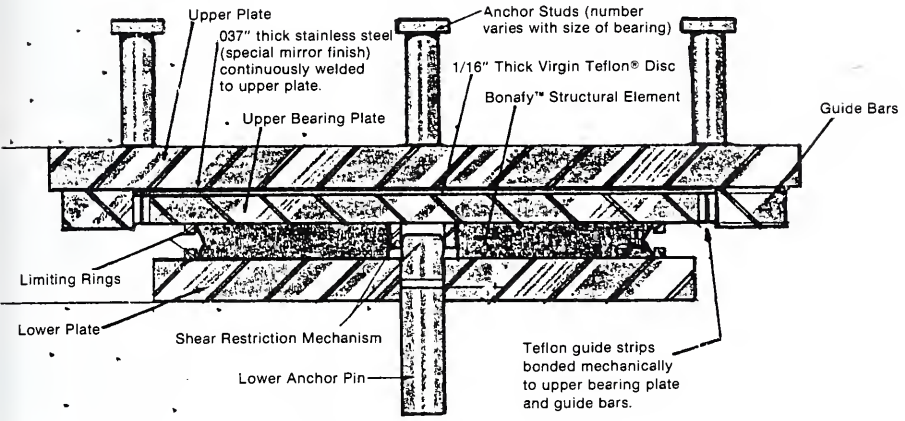
Upper Plate
.037" thick stainless steel (special mirror finish) continuously welded to upper plate.
Upper Bearing Plate
Anchor Studs (number varies with size of bearing)
1/16" Thick Virgin Teflon® Disc
Bonafy™ Structural Element
Guide Bars
Limiting Rings
Lower Plate
Shear Restriction Mechanism
Lower Anchor Pin
Teflon guide strips bonded mechanically to upper bearing plate and guide bars.

FIGURE 10—Unconfined elastomeric disc

attack, some designers do not find the exposed design of this bearing desirable.

3) PROBLEMS ASSOCIATED WITH BRIDGE BEARINGS

emperature effects

When one end of a given span is fixed and e other is free to move longitudinally, straining forces caused by changes in mperature are not produced. If both ends e restrained from expansion, as in the case expansion bearings that have seized, and the substructure resists thermal movement, en changes in temperature could generate rious forces in both the superstructure and bstructure. In some cases anchor bolts can form or even shear off.

Since the substructure is not immoveable, the thermal forces are great enough, the bstructure or a part of it will tend to move. masonry piers and abutments, bed-stone ints may open up, eventually allowing ıter to cause further damage.

Seizing of bearings can be caused by:

(1) Accumulation of dirt on bearing surfaces of plates, discs, rockers and rollers (see Figure 11).
(2) Excessive corrosion of expansion-bearing components or electrolytic corrosion between bronze and steel plates. This is very common in bridges that are located in marine environments and those exposed to deicing salts.
(3) Accumulation of debris in anchor bolt slots or improper positioning of the slot with respect to anchor bolts.
(4) Loss of lubricant in lubricated bearings.
(5) Broken or deformed mechanical components. This can be caused by uneven transfer of vertical loads to the bearings.
(6) Differential settlement and/or forward movement of the substructure.

The effects that frozen bearings may have on a bridge are very difficult to determine. For one thing, all components of a bridge do not respond to temperature changes in the same manner. A concrete deck has a lesser ability to expand than the steel supporting it. In addition, exposure to the sun and wind can cause variations in temperature to occur within the structure.

The amount of temperature movement of a structure varies with the length of span. Bridges in North America have almost always been designed for a temperature movement of one (1) inch in 100 ft. of length, corresponding to a temperature range of 120° F.

Since it is almost impossible to determine how "frozen" the bearings are, and therefore how much movement is being restrained it is very important to measure the position of the expansion bearing relative to the temperature of the span. This will help establish

FIGURE 11—Accumulation of dirt on bridge seat

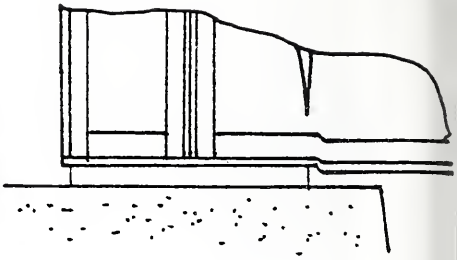

FIGURE 12—Bearing stiffener at centre of bearing

the magnitude of thermal forces that are being transferred to the structure because of temperature changes.

If the bearing seizes when the span is in a contracted position, subsequent expansion could cause the span to camber upward actually creating a desirable condition at certain temperatures. On the other hand, if the bearing seizes when the span is in an expanded position, contraction could cause the span to camber downward which will increase stresses in the span.

Thermal-force effects are resisted by the superstructure, the substructure and the anchor bolts. Theoretically, tremendous forces may be generated in the superstructure. In real life, however, these forces are limited by the resistance strength of the anchor bolts and/or any movement of the substructure. Small amounts of tilting can safely be accommodated in most abutments and piers which is one of the main reasons why many structures with bearing problems do not display noticable damage.

Restraining forces that remain in the superstructure are often dissipated by the various structural components and connections that comprise it. For this reason trusses have a greater ability to dissipate loads than through-plate or deck-plate girders. In rivited structures, any slackening of rivets that has taken place with time, can greatly reduce these forces.

For truss spans, the bottom chords are the most critically affected elements, particularly in the two end-bays nearest to the supports. Diagonals, verticals and connections (particularly at the bearings) in end-bays, and the diagonals of wind-braced bays may also be affected.

Through-plate and deck-plate girders are greatly affected by restraining forces. The most critical areas are the flanges, particularly the bottom flange immediately above the bearings. Theoretically, if a 70-fit. long DPG were fully restrained from movement, temperature changes of 50° F could cause the flanges to permanently deform.

Live load effects

Vertical live loads can cause problems, particularly under flat-plate bearings. The tendency for these bearings to rotate as the span deflects causes pressures under the inner edge of the masonry plate to increase when the load crosses the bridge. In some instances the rear edge may actually lift up, depending on the proportions of the plate. The train moving over the span produces a rocking motion on the plate, and while this might not be serious on short spans, damage to the bridge seat becomes quite possible as the span length increases.

Figure 12 shows a bearing stiffener placed approximately at the center of a typical flat-plate bearing. Rotation of the end of the span can sometimes result in slight distortions of the bottom flange and buckling of the web, assuming of course that the bridge seat can support the excessive forces produced.

If the bearing stiffener is placed at the inner edge of the masonry plate as shown in Figure 13, there is a possibility of crushing of

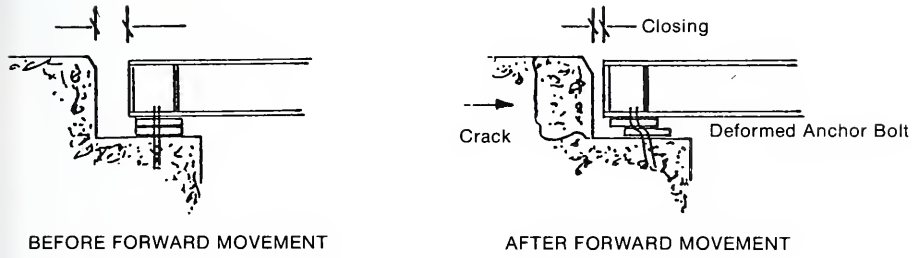

FIGURE 18—Tilting of supports

the bridge seat because of excessive concentrations of bearing pressures.

Roller bearings, which do not have provision for end of span rotation or have hinges that do not function, can cause additional bearing pressures to be put on leading rollers. This often causes depressions in the shoe and masonry plates, greatly affecting the mobility of the bearing.

Any deterioration of the masonry under the masonry plate can cause it to sink into the bridge seat (see Figure 14). A first sign of this is the presence of a fine powder around the edges of the bearing. Concrete will then begin to show cracks and will eventually break up.

If the masonry plate is of insufficient thickness, it may bend upwards around its edges, causing the span reactions to be distributed over a smaller plate area (See Figure 15). Dishing, as this is commonly called, is sometimes identified by a fine line of bright rust which may appear around the lower edges of the masonry plate.

Track lifts

Lifts often require spans to be temporarily supported on timber blockings, some of considerable thickness (see Figure 16). If left permanently, they will compress with time and decay, eventually affecting rail levels.

Metal shims which are to be placed under bearings permanently should be held firmly together. If too many are used or if the shim plates are too thin, they may become loose or corroded affecting the integrity of the bearing.

If the bearing is not properly shimmed, pumping action can take place, quickly leading to deterioration of the bridge seat and in many instances to damage of the bottom flanges of the span.

Substructure movement

Settlement of a pier or abutment can set up uneven bearing pressures which can cause bearings to malfunction. Closing and opening of the clearance gap between the span and top of backwall at opposite ends of the span, together with lifting of shoe plates are signs of differential settlement (See Figure 17). This problem can often be resolved by shimming the span.

Forward movement of a pier or an abutment is also a problem, especially when it uses up the allowance in the anchor-bolt slot of the bearing, preventing further expansion of the span. This may be recognized by a uniform closing of the clearance gap at one end of the span and opening by about the same amount at the other end along with deforming and possible shearing of the anchor bolts in the same direction (See Figure 18).

If the forward movement of the substructure is enough to close the clearance gap between the span and backwall, the restraining forces generated when the span expands can be large enough to break the backwall, particularly in masonry abutments. In such cases it becomes necessary to reposition the bearings and/or cut into the backwall to permit free longitudinal movements of the span.

Skewed spans

Because skewed spans have a tendency to creep laterally, their expansion bearings often lose alignment. Also, the practice of allowing the ends of longitudinal stringers for floor beams to be supported on bridge seats without any provision for rotation in two directions can cause bearing pressures to concentrate under one corner of the masonry plate.

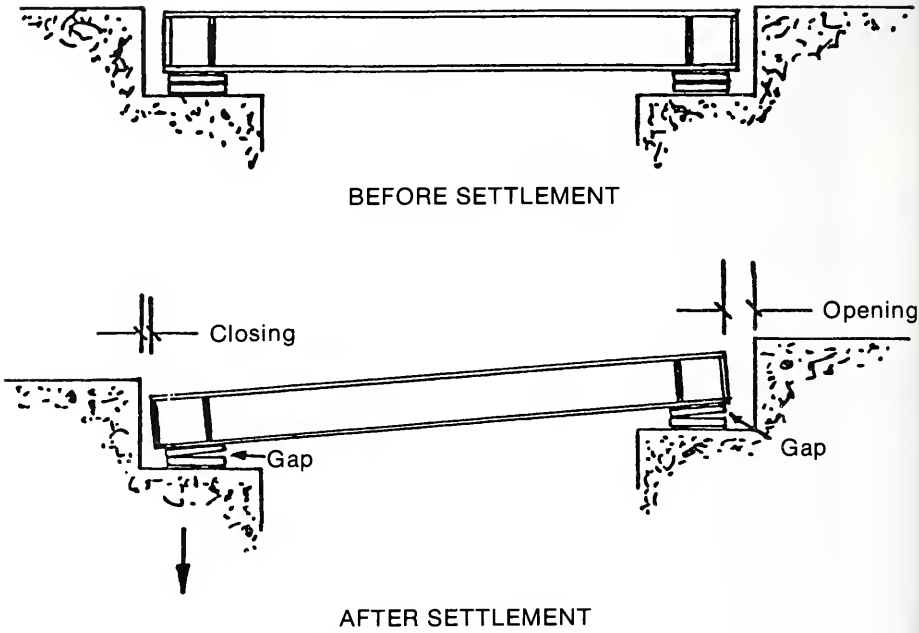

FIGURE 17—Settlement of supports

Moveable bridges

Moveable bridges are far more susceptible to bearing problems than fixed bridges, although the same kinds of problems occur in both types. The main difference is that being moveable, and hence operated by mechanical equipment, bearing distortions can affect the operation of the bridge.

Swing bridges are very sensitive because the bearings must support live loads when closed and must also be able to disengage from their supports to allow the span to swing open.

Bascule bridges open in a vertical plane and are generally not as greatly affected by bearing problems as swing bridges.

(4) MAINTENANCE OF BEARINGS

For any maintenance program to be successful, proper inspection procedures must first be established. Ideally, the following checks should be made during inspection:

(1) Examine all components of the bearings to verify they are functioning properly.
   (a) Note wear and tear in bearing surfaces of pins, rockers, rollers, etc.
   (b) Check for proper bearing alignment and looseness of fasteners and shim plates,

(2) Examine bearings for presence of corrosion, particularly between sliding surfaces and rollers.

(3) Verify that expansion bearings move freely and are clear of all foreign material. Rollers, rockers and hinges should bear evenly over their full length. The position of anchor bolts in anchor-bolt slots, the amount of tilt of rocker bearings, or the position of roller bearings should be noted as well as the outside temperature, at the time of inspection.

(4) Check anchor bolts for damage and verify that anchor-bolt nuts have been properly set on the expansion bearings to allow normal movement of the span to take place.

(5) Note the presence of dirt, debris and dampness on bridge seats and whether the bearings are in need of cleaning or greasing.

(6) If bearings are frozen, look for any

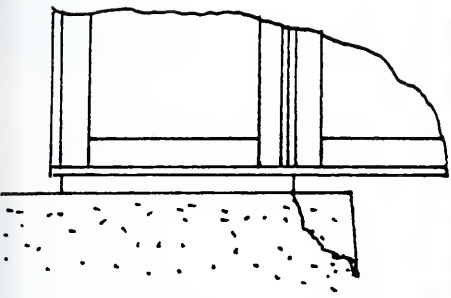

FIGURE 13—Bearing stiffener at inner edge of bearing

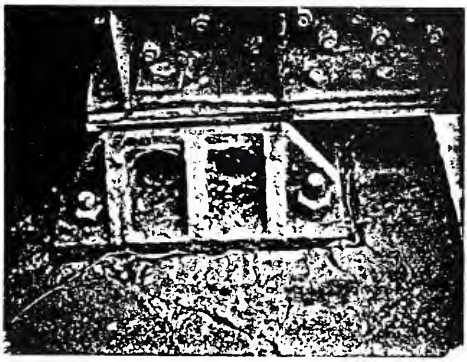

FIGURE 14—Sinking of bearing

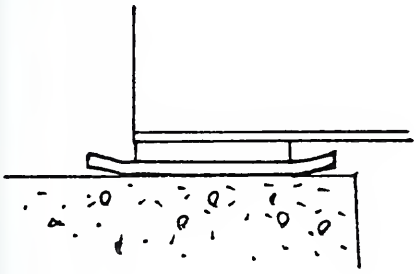

FIGURE 15—Dishing of bearing

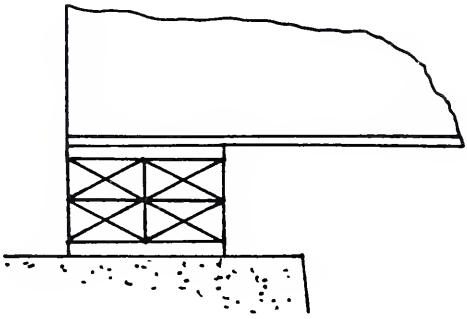

FIGURE 16—Wooden shims for track lifts

signs of damage, particularly in the bottom flanges at the ends of girder spans and in components of the end-bays of truss spans.

(7) Check for noticeable movement of piers and abutments which may affect the performance of the bearings. In particular, look for changes in gaps between spans and between end-spans and backwalls. Note the presence of cracks in the bridge seat.

(8) Examine masonry and shim plates for dishing and note whether this has been caused by the plates being too thin or by a deteriorated bridge seat.

(9) Verify if the bearing is properly seated on the bridge seat and if possible note whether there is any lifting of the bearing when a train crosses the bridge.

(10) Check that the bridge seat concrete or masonry is in good condition and its surface drains adequately.

(11) For elastomeric bearings check for splitting or tearing of pads either vertically or horizontally. Look for bulging of the pad under the passage of a train load.
Note the physical condition of the bearing and any abnormal flattening which may indicate overloading or excessive unevenness of loading.

(12) Bearings should be examined carefully after unusual occurrances such as bridge fires, derailments, vehicular collisions, earthquakes and battering from debris during periods of flood.

To keep bearings functioning properly, periodic "housekeeping" procedures should

be followed. Dirt and debris should be removed from bridge seats and bearing components cleaned, preferably using compressed air. Particular attention should be given to the accumulation of dirt in anchor-bolt slots and in between rollers. It is also important, when required, to lubricate the bearings.

If one end of a span is low, it should be shimmed before it affects the operation of the bearings. Using neoprene or another type of resilient pad under masonry plate will help prevent any further damage to the bridge seat.

If the bridge seat or backwall has been damaged, polymer concrete materials which are high in strength (5000–10000 psi) and are fast setting (1–3 hrs.) can be used at temperatures as low as 10° F (−10° C) to repair cracks and restore damaged bridge seats.

Where the expansion bearings have frozen and there is no visible evidence of damage, and instrument survey may be carried out at two different temperature levels to determine whether the substructure is adapting to thermal movements of the bridge span. If the amount of expected expansion or contraction of the span is about the same as the measured movement of the substructure, there should be no reason for immediate concern, providing the substructure itself has not been damaged.

If the measured movement is less or if there is no indication of substructure movement at all, then there is a strong likelihood that restraining forces are being imposed on the span. The bearings in this case, should either be repaired or replaced.

(5) REPAIR AND REPLACEMENT OF BEARINGS

The decision to repair or replace bearings is based on economics and of course the severity of damage. In the majority of cases, the costs associated with mobilization of work crews and equipment, jacking of spans, and interruption to traffic, are much greater than the cost of the new bearing components to be installed.

In the case of flat-plate bearings, there are no components to repair. The damaged plates must be replaced. For rocker and roller bearings it is often more economical to replace only the damaged components than replace the entire assembly. However, there is no general rule to follow, and each case must be considered separately.

If the bearings are to be replaced the question then arises, should they be replaced in kind or with an elastomeric bearing? In terms of cost, elastomeric bearings may generally be cheaper than roller bearings and some types of lubricated disc or rocker bearings, particularly those with bronze-alloy plates. For flat plates and most rocker or disc bearings it is more economical to remain with the metal bearing.

It may be desirable to use elastomeric bearings when the existing type of metal bearing is not appropriate. An example of this would be excessive bearing pressures under flat plates which would be relieved if the span were permitted to rotate.

In addition, the ability of elastomeric bearings to accommodate rotations in any direction would reduce many of the problems associated with skewed spans.

Almost all railway bridges have been constructed on metal bearings. Most bearing problems occur because the bearings are very old and have not been regularly maintained over the years. Because of their proven durability, the tendency has almost always been to replace bearings in kind, and as a result many designers are hesitant to switch to the more modern elastomeric bearings.

(6) DESIGN CONSIDERATIONS

Bridge bearings represent only a small portion of the total initial cost of a new bridge. However, the costs associated with repairing or replacing them at some future time may be considerable. The designers of steel railway bridges built in North America 80 years ago did not pay enough attention to future maintenance requirements. It was not possible to anticipate the drastic changes in loading and even environment that have since taken place. It is only recently that designers have been looking at total costs associated with a structure over its lifetime and not just the initial cost.

With this in mind, the following details should be considered during the design stage

o help reduce problems associated with ridge bearings and also facilitate main-enance procedures:

(1) A minimum of 4 inches and preferably 6 inches of clearance should be provided between the end of the span and the backwall.
(2) Abutments and piers should be designed to allow water to drain away from the bearings.
(3) Recessed areas should be provided in the abutment to accommodate the height of jacking equipment. Spans should be designed with provisions for jacking.
(4) Spherical disc bearings or elastomer bearings should be provided in skewed bridges.
(5) Abutments should be designed to provide proper access at the bearing for cleaning and repairing.
(6) At least 6 inches of concrete should be provided from the edge of the masonry plate to the front face of the bridge seat.

By comparison, European designs place nuch more emphasis on bearing details. For ne thing their structures are more slender nd therefore can be more seriously affected y bearing problems. In addition, many rail nes carry extremely dense traffic making it ostly and undesirable to interrupt service to arry out repair work.

The German Federal Railway (Deutsche Bundesbahm) had adopted a maintenance rogram in which all bearings on a given tructure are replaced every 30 years. To acilitate this, the spans and abutments ave standard details that allow any type of earing to be specified. Their opinion is that, ince it is inevitable that a structure will equire maintenance at some point during its fetime, by removing as many obstacles as ossible, the most efficient and economic naintenance solutions may be considered.

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President Hyma: Thank you Steve, for a fine report. Non-functioning bearings can lead to many other problems. I want to thank all the members who served on your committee and contributed information. This is the primary function of our organization. Reprints of the report are available on the back table.

This afternoon is again left free so that you will have time to visit the REMSA exhibits.

We will reconvene in individual session again in the morning in this same room at 8:30 A.M. You are reminded that drawings for the two $25 door prizes will be held at the close of the session tomorrow and you must be present to win.

The meeting is adjourned.

THURSDAY MORNING

October 7, 1982

President Hyma: Good morning members and guests. Welcome to the final session of our 87th Annual Conference.

The registration stands at 595 railroad members, 674 associates and 491 guests for a total of 1,760 and that is a final figure. This compares to 759 last year in Chicago and 2,445 in Atlanta three years ago.

Ladies registration was 537 and Mr. Lewis, our ladies entertainment chairman, tells me that 334 ladies took the tour yesterday. From all reports I have received a good time was had by all.

Our first report this morning is that of Special Subject No. 1 and Jim Davidson, Director, and sponsor of this committee will introduce his chairman.

Mr. Davidson: Our next speaker is Tom Kuhn, who will present a report on movement of locomotive cranes, based on extensive research with all major railroads and with crane manufacturers.

Tom is now Engineer of Special Projects in the Bridge Department of the Missouri Pacific. He started working on the MOP in 1966 while a co-op student at the University of Missouri at Rolla and decided he liked the people and the work so well that he went with the MOP after graduating with a Bachelor of Science degree in 1970. In the intervening years, he has served as bridge inspector, B&B superintendent and pollution control engineer prior to his present appointment.

We will have an opportunity to ask questions after the conclusion of his talk and would ask that you keep them until that time. And now, Tom Kuhn.

SPECIAL SUBJECT NO. 1

Movement of Locomotive Cranes

Chairman: T. E. Kuhn, Engr. Spec. Proj., MP, St. Louis, MO
1st Vice Chairman: P. L. Barrett, Br. Analyst., ATSF, Chicago IL
2nd Vice Chairman: T. H. Clark, Gen. Supv. Str., Chessie, Huntington WVA
Committee: A. J. Clark, Const. Engr., Br., C&NW, Boone IA
J. F. Stanley, Supv. Br. Mtce. Sys., Milwaukee, Elgin IL
J. W. Chambers, Br. Const. Engr., MP, St. Louis MO
R. D. Patton, B&B Proj. Supv., Southern, Chattanooga TN
C. E. Thompson, B&B Mstr., CP Rail, Nelson, Canada
C. R. Wahlen, Asst. Engr. Br., AT&SF, Chicago IL
S. J. Fainbloom, Mgr. Wk. Equip., CN, Montreal, Canada
N. D. Bryant, Asst. Chf. Engr. Mtce. & Str., BN, St. Paul MN
L. Smolsky, VP & GM, HH&I, Penndel PA
D. E. Buchko, B&B Supv., ICG, Carbondale IL

The report of the Committee on Special Subject No. 1, "Movement of Locomotive Cranes", was compiled from a survey of various railroads to determine their methods. The report is intended to present a compilation of the results of the survey, to analyze some of the results, and to make the information available to those people most closely involved with issuing instructions on methods of handling locomotive cranes so that they can compare their methods to others and arrive, hopefully, at the best method. The report is not intended to make any recommendation on the part of the American Railway Bridge and Building Association as to the method to use.

The subject of "Movement of Locomotive Cranes" was originally suggested for consideration for a report as a result of a new locomotive crane being derailed while being transported in a train. Recently, too, there has been some coverage in trade magazines about a "new breed" of locomotive cranes specially prepared and equipped for high-speed movement up to 60 miles per hour.

Our method in assembling the material from which to prepare this report was to send a questionnaire to a large number of railroads soliciting their responses to various questions concerning their particular methods of handling locomotive-crane movements. The results of responses to the questionnaires were tabulated and analyzed for the major similarities of methods and diversities of methods.

The areas covered were special equipment for movements, either under their own power or in trains, applied to locomotive cranes and convoy cars, special preparation required to get the crane ready to move, such as detaching and/or restraining the boom; restraining cab rotation; slacking or detaching cables and handling of counterweights; actual handling of the crane in train movements, such as position in the train; orientation of the crane; speed restrictions and special instructions given to train crews and/or machine operators; and any differentiation in handling based on the length of the move.

Evidently there is a good deal of interest in the subject. Out of the 24 railroads polled, 18 responded to the questionnaire. We also received responses from the two manufacturers we contacted. As one might expect, certain specific points showed almost unanimous agreement on handling and, on other points, there was tremendous diversity in the responses.

Handling in trains

In discussing the handling of locomotive cranes in train movements, one must differentiate initially between the more "conventional" cranes fairly common to all railroads and those few cranes which have been specifically prepared for "high-speed movement" at up to 60 miles per hour. Only two railroads responded with information concerning these high-speed cranes, and both of them also have the conventional cranes.

As you would expect, a crane to be moved in a train must be equipped with certain standard equipment such as standard wheels and trucks, couplers, brakes and train-line air. Similarly, the majority of the responding roads indicated some means of disengaging the travel gears of the crane, and a requirement to add additional oil to the travel mechanism. Most of the older cranes have fixed counterweights. Many newer cranes have removable counterweights. The removal counterweights permits a more equal weight distribution to be accomplished which generally makes the cranes ride better in a train.

Every response showed that an additional car was required to carry the boom and/or boom overhang. All but one road indicated that a specially equipped boom-car was utilized. The arrangements of the various cars varied with the particular road's instructions concerning whether the boom was attached or detached for movement. In general, all of the boom-cars had some sort of pedestal or rest for the boom and some means, naturally, of restraining the boom for movement. Also, if the boom is detached, the blocking holds the boom in the proper position for reassembly, thus speeding up the process of preparing the crane for work after a move. Most cranes carry a variety of auxiliary equipment, such as magnets, buckets, pile hammers and blocks, and a captive car can be equipped to safely carry all of the crane's equipment efficiently.

In preparing a crane for movement, the conversion must be made to train air and, as mentioned previously, most of the responding roads required disengagement of travel mechanism and addition of lubrication to the travel gears. Some cranes required changing blocking in the under-

Idler car used by SOO Line. Crane is moved with boom attached but cab locked against rotation.

rriage to provide the proper side clearance r movement in trains. Several roads dicated that they required safety chains etween a detached boom and the crane self.

our basic configurations

So much for the similarities. The results of ie survey indicated that there are four basic onfigurations utilized in movement of ocomotive cranes in trains; boom attached—ables slacked; boom attached—cables de-ached; boom detached—cables slacked; nd boom detached—cables detached. The ajority of the roads responding, 60 percent, se one of the boom detached methods, and f those, half slack the cables and half detach hem. Of the 40 percent responding that they eave the boom attached, half slack the ables and half detach them. So you can see hat there is a pretty diverse approach. Let us onsider the advantages and disadvantages f the various methods.

I would suppose that, from a transportation standpoint, the boom detached—cables detached configuration would be the most desirable. In effect, the crane body and the boom can be considered as separate loads. There is less likelihood of damage in case of pull-apart or derailment. The boom-car does not have to be anything more than a regular flat car. It is not necessary to lock the couplers between the crane and boom car, or even to keep the cars together. The newer cranes with removable counterweights achieve the nearly equal weight distribution that allows higher speeds. Both roads using high-speed cranes use the boom-detached configuration, one with all cables detached, and one with the boom cables detached and hoist cables slacked. Disadvantages of this method involve the additional time required to remove the boom prior to movement and to reassemble the crane after arrival at the destination. Several roads responded that it was necessary to have another crane handle the boom. Without the use of another crane, there is a possibility that difficulty can be encountered in removal and reinstallation of the boom due to the effects of curvature and/or super-elevation.

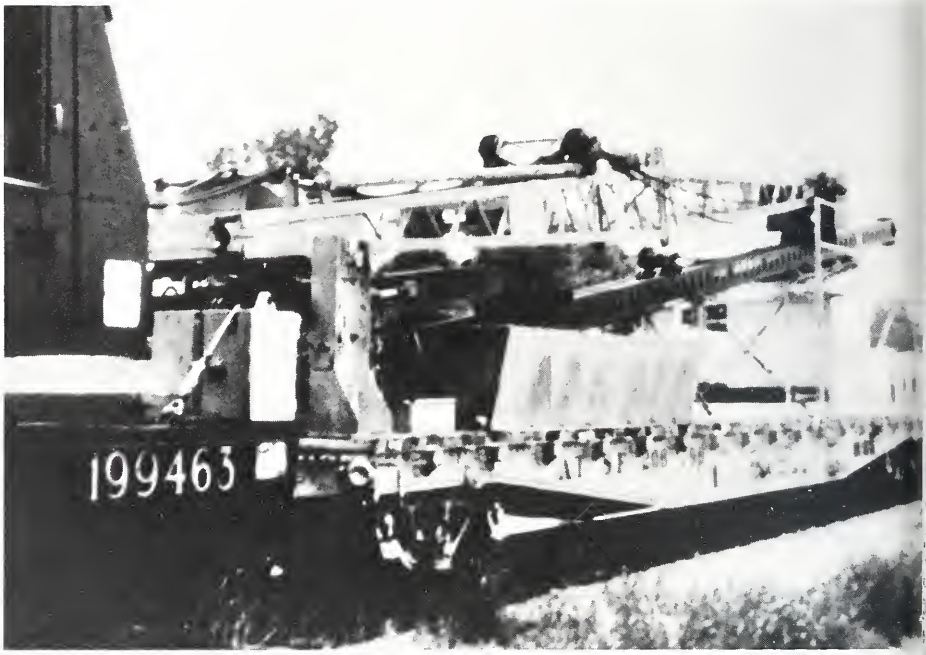
The boom detached—cables attached method offers a time advantage in preparation for movement and reassembly in that it is not necessary to detach and stow the boom and hoist cables. There is, however, an exposure to damage in case of derailment or pull-apart. One railroad indicated they they install safety chains between the crane and boom. However, one railroad related the experience that, in a derailment, the cables pulled the boom off its rest on the boom-car, damaging both the car and the boom. There is some complication in handling the crane convoy since the crane and boom-car must stay coupled together.

Moving a crane with the boom attached, offers some time advantage over movement with the boom detached in that you can couple the crane to the boom car, lay the boom down and secure it without having to spend the additional time, remove the boom foot-pins and in avoiding delay due to misalignment of connections caused by curvature or super-elevation. Utilization of the boom attached—cables slacked configuration puts the machine in almost work-ready configuration on its arrival at the work location. Disadvantages of the boom attached configuration are common to both the cables detached and cables slacked modes. Generally, this configuration requires a boom-car capable of supporting the boom at height above the normal car floor height due to the location of the boom foot-pins above the top of the car body.

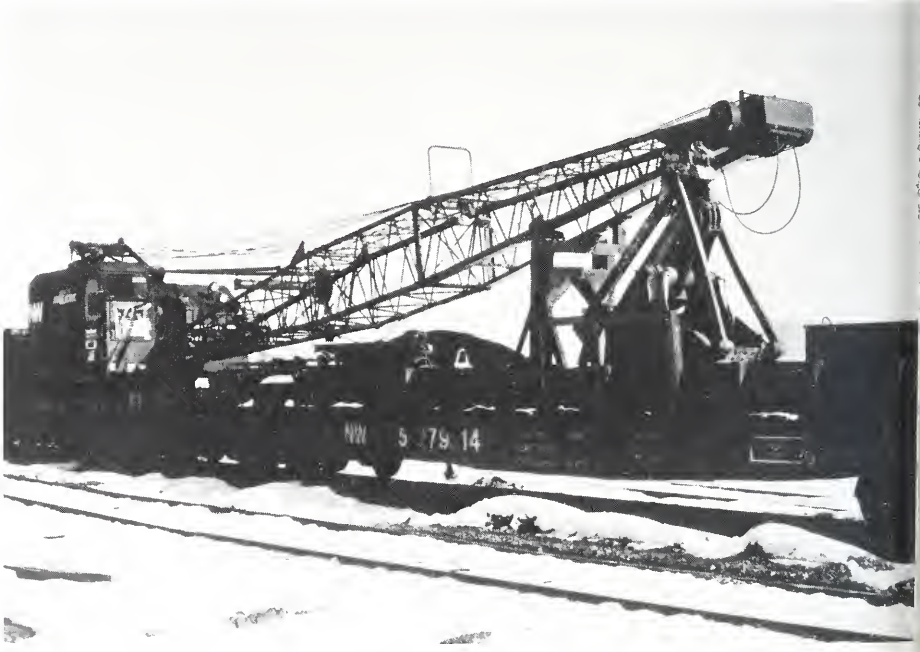
Similarly, except for one road, some type of restraint was required that would hold the boom down on the rest without restraining its longitudinal and horizontal movement for curve negotiation. The exception was a road that reported they left the cab section of the crane free to rotate so that the crane's car body moved under the upperworks allowing the boom to pivot on its rest, without moving laterally, and making the crane and convoy car work much in the manner of a bolstered load.

Removal counterweights

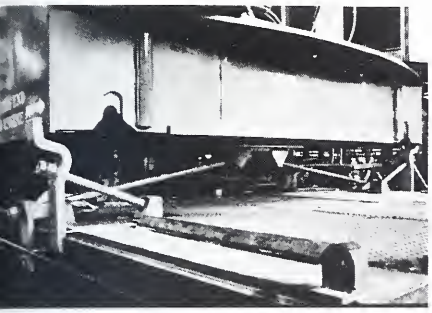
The methods pertaining to counterweights seem to be more a function of the age, capacity and style of the crane than merely of personal preference. Most of the newer cranes (probably largely due to the fact that they are of a higher capacity and, therefore, have a larger counterweight) are equipped with removal counterweights. If left at-



Boom moved with hammer and leads attached to boom.



Boom attached—cab rotates.



Cab restraint

Cab restraint

ached, the counterweight would make one nd heavy and make the other end relatively ight. The result would be an unstable oading in the train. A removable counter- veight permits achievement of better bal- nced axle loads. Both of the "high-speed" ranes are equipped with detachable coun- erweights. The majority of the roads with letachable counterweights have a means of towing and securing the counterweight on he car body. Of the three who carry the ounterweight on a separate car, two re- ported that they used another crane to move he counterweight while the third moved it vith the crane's boom before it was detached.

Cranes moved with counterweight at- ached, require blocks or jacks of some sort etween the counterweight and the car body o transfer the weight to the car body and educe rocking and wear and tear on the otating gear. The single exception is the oad that leaves the cab free to rotate, and it rovides blocking to limit the rocking. On he subject of restraint of the upperworks rom rotation, there was, with the one xception mentioned previously, a general equirement to fasten the upperworks to the ar body. Swinglocks, tie-down rods, clamp locks and jacks were the means used to estrain the upperworks.

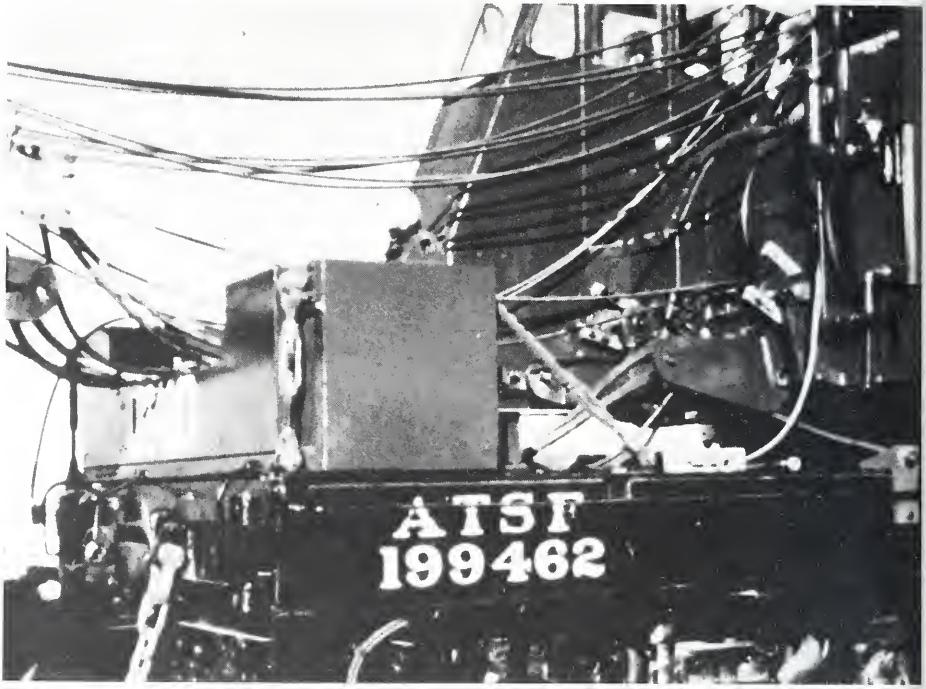
ositioning crane in train

The actual handling of the cranes in novement drew a rather diverse response. here was an almost universal requirement o orient the crane with the heavy end eading (or with the boom trailing), if a heavy end" exists. As has been mentioned reviously, cranes with detachable counter- weights achieve an almost equal weight distribution on the axles. Several roads pointed out that, with the boom detached and the counterweight properly stowed, either end could lead.

The majority of the roads required the crane to be handled at or near the end of the train. Generally, these roads cited slack action and buff forces for the justification. Also, the crane can be observed more readily from the caboose. Of those roads that require cranes to move at or near the head of the train, all but one wanted four or five cars to act as a buffer between the crane and the engine. That one road required the crane to be moved immediately behind the engine.

Speed restrictions for cranes moving in trains generally ranged from 25 miles per hour to 45 miles per hour except for the "high-speed" cranes that move at speeds up to 60 miles per hour. The vast majority of roads (some 12 of the 18 reporting on conventional cranes) limited maximum speed to 25 or 30 miles per hour. Of these allowing speeds above 30 miles per hour, class of track and orientation could require lower speeds. The two manufacturers re- sponding recommended limits of 25 and 36 miles per hour except for the specially prepared cranes.

The majority of the roads responding indicated that there was no requirement for the crane operator to accompany the crane while in movement on trains. Of those indicating that the operator was required to accompany the machine, most left it at the operator's discretion, whether it was by riding on the train or following in a personal vehicle. Generally, the operators who fol- lowed the movements were required to



Boom detached—cables slack.

inspect and check the machine at terminal points and stops to assure that the machine is properly secured and has required oil levels, and other times to observe the crane while moving in train to assure the machine is traveling properly and that the train crews are observing applicable restrictions. Although no response was received, I do know of one road that required operators to ride in the machine with a speed indicator and brake control to assure that the speed restrictions are observed.

All but one of the roads responded that they issued some type of special instruction to train crews. The types of instructions included Timetable Special Instructions, General Orders, Wire Messages, Waybill Instructions and stencilling of the crane (with "Tow in this Direction" and/or the speed restriction).

Other miscellaneous requirements specified by the responding roads included special pre-move inspections by the operator, Work Equipment Supervisor and Car Department; special clearance for machines that exceeded published clearance on a given line; and loosening or removal of the kingbolt nut to permit freer movement of the car body on the bolster. The manufacturers recommended replacement of the heavy slotted nuts with jam nuts and washers to provide additional slack.

Disassembly and reassembly time

Aside from the primary concern for the safety of a machine in transit, the time and attendant expense involved in preparing a crane for movement and returning it to a workwise state is probably the greatest concern. From this standpoint, the high-speed cranes may have a decided advantage over the "conventional" crane in that their total in transit time for a given move may be considerably less than that required for a conventional crane. However, if the primary concern is getting the crane tied down and ready to move, as may be the case if gang-outfit cars and material cars with a speed restriction are moving too, the conventional

cranes may be advantageous in that they generally require less time to disassemble and reassemble.

The minimum time reported for the disassembly and reassembly of a crane was one hour. This was for a crane moved in the boom attached—cables slacked configuration with the counterweight attached. The maximum time reported was one day for each function for a crane moved with the counterweight detached (and handled by another crane) and boom detached—cables slacked. However, the majority of the railroads responded that it took something on the order of 1 to 4 hours for each function.

Occasionally, it is more advantageous to move a crane under its own power. Few railroads reported that they would move any great distance in this manner although one road said moves to 300 miles would be made by the crane in a more-or-less workwise mode under its own power and another would move up to 600 miles with the crane under its own power.

One railroad responded that they utilized 45-ton hy-rail cranes that could be tied down on a regular flat car and move in a train as a regular load. However, this was the exception rather than the rule.

In summary, the major differences between a conventional locomotive crane and a high-speed locomotive crane are the ability to achieve a nearly equal weight distribution on the crane axles by proper placement of the detached counterweight and the utilization of a more conventional railroad springing and side bearings. Movement of these cranes at speeds up to 60 miles per hour requires removal of the boom creating, in effect, two separate loads which may be connected by the slacked cables.

While the preparation of cranes for high-speed movement and the required reassembly at the destination may require auxiliary equipment to handle the boom and may require more time, the additional cost of equipment and time can be more than offset by the time saved in transit. However, conventional cranes are much more common than these high-speed cranes and may be more attractive when utilized and moved in conjunction with gang outfit cars or material cars that requirement movement at restricted speeds.

On the whole, it would probably be most advantageous to arrive at a way of performing the minimum amount of work necessary to prepare a crane for movement that would safely be consistent with the requirements for:

(1) Distance of move.
(2) Maximum speed at which move can be made.
(3) Urgency with which the move must be made.
(4) The prevailing instructions of the individual company.

Mr. Davidson: Thank you for an excellent report Tom. If there are no questions, this will conclude the report of this committee.

President Hyma: Thank you Mr. Kuhn. Your committee has done a good job. With the different types of cranes and pile driving leads, there is obviously some difference of opinion as to how they should be moved. The membership will now have the benefit of knowing what some of the other roads are doing. Reprints of this report are available on the back table. I see that our Secretary is now with us which indicates the Roadmasters have concluded their business session and we can proceed with ours. Will the officers please come back to the head table.

Mrs. Weissmann, will you please present the Secretary's report.

Membership Report
September 1, 1981 to August 31, 1982

ACTIVE MEMBERS			
Total Active members—September 1, 1981			432
New Active members since September 1, 1981			44
Reinstated-paid back dues			4
Transferred from Associate			2
			482
Less: Transferred to Life	12		
Deceased	3		
Dropped for nonpayment of dues	28		
Transferred to Associate	2	45	
TOTAL ACTIVE MEMBERS			437
ASSOCIATE MEMBERS			
Total Associate members—September 1, 1981			94
New Associate members since September 1, 1981			13
Transferred from Active			2
Reinstated-paid back dues			1
			110
Less: Dropped	9		
Transferred to Active	2	11	
TOTAL ASSOCIATE MEMBERS			99
LIFE MEMBERS			
Total Life members—September 1, 1981			148
Transferred from Active			12
			160
Less: Deceased	4	4	156
HONORARY MEMBERS			
Total Honorary members—September 1, 1981			9
Less: Deceased	2	2	
TOTAL HONORARY MEMBERS			7
TOTAL MEMBERSHIP—ALL CLASSES—AUGUST 31, 1982			699

August 31, 1981

Active	432
Associate	94
Life	148
Honorary	9
	683

September 16, 1982

President Hyma: Thank you Mrs. Weissmann. Mr. Sturm, can we have the Treasurer's Report, please.

Treasurer's Report
September 1, 1981 to August 31, 1982

Checking account balance, August 31, 1981		$ 2,588.58
RECEIPTS		
Dues	$ 4,422.59	
Advertising—1979	300.00	
1980	12,933.87	
1981	10,376.56	
1982	700.00	
Interest on checking account	173.71	
NSF check re-deposited	17.00	28,923.73
		31,512.31
DISBURSEMENTS		
Salaries (Secretary and Assistant)	$ 4,998.00	
FICA (on payroll)	333.86	
Federal Unemployment Tax	52.31	
State Unemployment Tax	2.90	
Department of Labor	13.84	
Office rent, telephone, electricity	565.86	
Postage	880.00	
Office supplies	220.73	
Advertising—1979 (APC proportion)	254.09	
1980 (APC proportion)	5,408.56	
1981 (APC proportion)	616.00	
Membership certificates	202.87	
Conference expense—1981	833.12	
1982	553.87	
1980 Proceedings	4,863.76	
1981 Proceedings	3,000.00	
Executive Board Meetings	319.15	
Printing and stationery	700.12	
Machine rental and repair	123.04	
Fire insurance premium	10.88	
Miscellaneous	420.92	24,373.88
Checking account balance, August 31, 1982		$ 7,138.43

Balance August 31, 1981—$2,588.58

September 7, 1982

President Hyma: Thank you Mr. Sturm. As I indicated yesterday, this report is as of August 31 and does not reflect our current status. A rough review of conference receipts and expenses indicates we should leave here in the black, however.

The Auditing Committee's report will now be presented by Mr. Denz, our Senior Vice President.

September 7, 1982

TO: MEMBERS OF THE AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION

Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period from September 1, 1981 to August 31, 1982, inclusive and have found them to be correct as of August 31, 1982.

Respectfully submitted,
J. R. Iwinski, Chairman
J. R. Williams
H. M. Wilson

You have now heard the Secretary's report, the Treasurer's report and the report of the Auditing Committee. Are there any questions or comments regarding these reports? If not, I will entertain a motion that the reports be accepted as presented. Is there a second? It has been moved and seconded that the reports be accepted. All in favor—Aye? Opposed—Nay? The motion is carried.

I will now call on Mr. Anthony, Chairman of the Membership Committee.

Mr. Anthony: Mr. President, members and guests of the American Railway Bridge and Building Association. At present there are seven honorary members of the Association, leaving three vacancies. Honorary members may be proposed by not less than six active members and elected by the unanimous vote of the members present at a regular meeting. At the last Executive Committee meeting, the following Life Members were proposed by more than six members for elevation to the status of honorary member.

W. F. Armstrong, member since 1947, officer and director from 1962–1968, President 1968–1969, Treasurer 1978–1981 and now retired Engineer Buildings, Chicago & North Western Transportation Company.

J. W. DeValle, member since 1959, officer and director 1962–1967, President 1967–1968, retired Chief Engineer, Bridges, Southern Railway.

E. E. Runde, member since 1959, officer and director 1967–1973, President 1973–1974, retired Construction Engineer Structures, Illinois Central Gulf.

I hereby move that Messrs. Armstrong, DeValle and Runde be made honorary members of the American Railway Bridge and Building Association.

President Hyma: You have heard the motion. Is there a second? All in favor—Aye? Opposed? The motion is carried. Messrs. Armstrong, DeValle and Runde are now honorary members and will be so notified.

Mr. Anthony also has a report on the Constitutional Amendment.

Mr. Anthony: Presently, the Constitution requires the Secretary to be an officer of the Association, officers to be members and members to be a person in a position above rank of gang foreman in connection with engineering construction and maintenance for railway buildings, etc. The intent and past history of the Association has been to appoint the Secretary by a majority vote of the Executive Committee rather than by filling the position through election by vote of the members at the Annual Meeting.

Past practice has also been to fill the position of the Secretary with one most

qualified in the skill of the secretarial profession and not require the Secretary to also be a person in a position above rank of gang foreman in connection with engineering, construction and maintenance for railway buildings, etc.

A solution appears to be that of not requiring the Secretary to be an officer of the Executive Committee, or a full member of the Association. The Secretary could be an associate member of the Association which provides all rights of membership except those of voting and holding office.

To effect this course of action, the Constitution should be changed.

The Constitution may be amended at any regular meeting by a two-third's vote of the members present, provided that notice of the proposed amendment has been sent to the members at least 30 days previous to the regular meeting.

Notice of the following proposed amendment has been published twice, once in the July 1981 Newsletter and again in the 1981 Proceedings of the 86th Annual Conference of the American Railway Bridge and Building Association.

Therefore, Mr. President, I move that the following changes be made to the Constitution:

1. Article IV, Section 1, drop words "a secretary."
2. Article VI, change title of section to read "Election of Officers and Secretary and Tenure of Office."
3. Article VI, Section 2, drop word "Secretary" in first sentence.
4. Article VI, Section 3, change to read, "The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Commitee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee."
5. Article VI, add new Section 4, "The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee."
6. Article VI, Section 4, renumber to "Section 5".

President Hyma: Thank you Mr. Anthony. You have all heard the proposed Constitutional Amendment. I will now entertain a motion that the change to the Constitution be accepted. Is there a second? Discussion? All in favor—Aye? Opposed? Motion is carried.

Mr. Laga will now present the report of the Resolutions Committee:

Report of Resolution Committee

MR. PRESIDENT, as a token of appreciation for the time and effort certain individuals and organizations have contributed to make this, the 87th meeting in the 92nd year of the American Railway Bridge and Building Association an outstanding success, the Resolutions Committee presents the following resolutions:

BE IT HEREBY RESOLVED that the thanks of the Association be extended to Reverend James Taglauer, Pastor, First English Lutheran Church, New Orleans, who was so kind to come among us and invoke the blessing for spiritual assurance.

BE IT FURTHER RESOLVED that the thanks of the Association be expressed to the prominent speakers who gave of their time and so capably shared their knowledge and counsel with us, especially

R. E. Haacke, AREA President,

W. J. Gallagher, REMSA President,

J. H. Bush, REMSA First Vice President,
W. S. Autrey, Chief Engineer, Santa Fe,
J. D. Jardine, Asst. Chief Engineer, CP Rail,
M. C. Purbrick, Director of Civil Engineering, British Railway, London, UK,
A. H. Meyers, Assistant Engineer-Design, Southern Pacific,
H. F. Longhelt, Deputy Chief Engineer—National Operations, Amtrak,
P. K. Ogden, Chief Engineer—Systems Gangs, Southern Railway,
G. E. Krupa, Sr. Staff Engineer, Illinois Central Gulf,

BE IT FURTHER RESOLVED that our thanks be expressed to Mrs. W. R. Hyma and Mrs. K. W. Sutherland and their committee for their efforts in arranging registration and entertainment for our wives and to the untiring efforts of the ladies who assisted with registration.

AND BE IT FINALLY RESOLVED that the Association expresses its thanks to its chairmen and their committees for their work in preparing the reports which were presented at the meeting, also to the railway companies who provided assistance at the registration desk; to REMSA and all its members for the fine banquet we enjoyed and the outstanding exhibits, here at the Superdome and the Amtrak Passenger Station, as well as to the members of our Executive Committee and to our President, Mr. W. R. Hyma, who has spent so much of his time and effort in guiding the affairs of our Association over the past year.

MR. PRESIDENT, we recommend these resolutions be made a part of the official record of this Association and that copies be presented to all concerned parties.

Respectfully submitted,
H. J. Laga, Chairman
Resolution Committee

President Hyma: Thank you Mr. Laga. The recommendations of your committee will be carried out.

Mr. Michel will now present the report of the Necrology Committee.

Report of Necrology Committee 1981–1982

To the President and Members of the
AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION:

It is with grief and regret that we report the known loss of nine (9) members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of any, please report their names to the Secretary. The following have been reported since our last Annual Conference in September 1981.

ACTIVE MEMBERS	TITLE-RAILROAD-LOCATION	JOINED	DECEASED
J.T. Doherty	Environ. Safety Engr. E.J.&E. Joliet, Il	1979	1982
J.G. Sanders	Mast. Carpenter Seaboard Coast Line Douglasville, Ga	1976	1981
S.L. Starling	Mast. Carpenter Seaboard Coast Line Waycross, Ga.	1961	1981
HONORARY MEMBERS			
N.D. Howard	Exec. Secretary A.R.E.A. Honolulu, Hawaii	1926	1981
L.C. Winkelhaus	Arch. Engr. C.&N.W. Trans. Co. Chicago, Il	1934	1980
LIFE MEMBERS			
A.C. Hoyt	B.&B. Engr. E.J.&E. Joliet, Il.	1947	1981
F.W. Hutcheson	B.&B. Supvr. Chessie System York County, Va.	1938	1981
H.F. Lucas	Asst. Engr. C.M.S.P.&P. Chicago, Il.	1952	1982
P.V. Thelander	Asst. Ch. Engr. C.&N.W. Trans. Co. Chicago, Il.	1939	1981

Respectfully submitted,
J.N. Michel, Chairman

President Hyma: Thank you Mr. Michel. Let us stand for a moment of silent prayer in remembrance of these departed members.

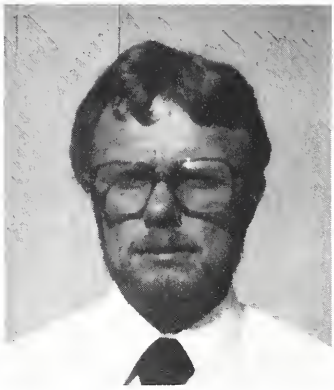
(Pause)

Please be seated.

At this time, I will ask Mr. Laga, the sponsor of the last special subject committee to introduce his chairman.

Mr. Laga: Our next speaker is Don Ladner, who will present a report on Special Subject No. 2, Culvert Maintenance and Replacement.

Don is a 1973 graduate of the University of Illinois in Chicago. In 1973 he started with the Chicago and North Western Transportation Company as a management trainee bridge designer. In the intervening years he has worked as assistant general bridge inspector, B&B supervisor prior to his appointment as assistant engineer. Don.



D. R. Ladner

SPECIAL SUBJECT NO. 2

Culvert Maintenance and Replacement

Chairman:	D. R. Ladner, Asst. Engr., C&NW, Boone IA
Vice Chairmen:	J. G. Robertson, Mgr. Engr. Des., B&LE, Greenville PA
	G. E. Scott, Sys. Supv. Br. & Str., CN, Montreal Canada
Committee:	W. E. Brakensiek, Asst. Chf. Engr., MP, St. Louis MO
	J. C. Calhoun, Gen. B&B Supv., Southern, Chattanooga TN
	W. Carver, Asst. Supv. Mtce., BS, Fairfield AL
	T. Christenson, Mgr. Engrg., Osmose, Madison WI
	E. B. Dobranetski, Engr. Fac. & Strs., B&LE, Greenville PA
	P. Fatula, Prog. Engr. Trk., Conrail, Voorhees NJ
	M. R. Garcia, Engr. Asst., C&NW, Chicago IL
	W. J. Gunkle, Sr. Str. Insp., Conrail, Philadelphia PA
	R. C. McMaster, Mgr. Fac. & Str., B&LE, Greenville PA
	A. Matt, Gen. Fmn. B&B, ATSF, LaJunta CO
	R. J. Posthauer, Sr. VP, Seelye Stevenson Value & Knecht, Plainview NY
	C. M. Russell, Gen. B&B Supv., Southern, Greensboro NC

G. L. Tysinger, Engr. Des. & Constr., Clinchfield, Erwin TN
D. D. Olson, Asst. B&B Supv., C&NW, Waukesha WI
E. E. Runde, B&B Supv (Ret.) ICG, E. Dubuque IL
D. J. Lewis, Sr. Str. DSCNR., ICG, Chicago IL

Culverts are transverse drainage structures that transmit fluids from one side of a fill section to the other. They differ from bridges in that they do not have a separate substructure and superstructure, but rather the two features combined into one.

The size and type of culverts found in use on railroads varies tremendously, from 18 inch vitrified clay to 50 feet stone arches. Many railroads refer to these larger structures as bridges for inspection and record-keeping purposes.

Culverts are made of various materials, including wood, brick, vitrified clay, stone, cast iron, corrugated metal, steel, concrete or various combinations of the above.

Some of the earliest culverts used on railroads were made of wood, brick and stone. The timber box culverts were usually constructed of native timber. The stone boxes and arches were usually built from hand-cut native stones, primarily sandstone and limestone.

Near the turn of the century, cast-iron pipe became available. For small openings, it provided an economical structure that was relatively easy to install.

At about the same time, concrete was becoming an important building material. It could be formed into arches and box culverts, doing away with much of the labor required to cut and place masonry.

Concrete pipe, both reinforced and plain, soon followed as an alternative to cast iron. Today, it is available in round, eliptical and arched shapes in sizes up to 10 feet. Properly installed, concrete pipe can provide a long-lasting structure.

In recent years, corrugated metal pipe has become increasingly popular due to its lighter weight and somewhat lower initial cost. Corrugated structures range in size from 18 inches in diameter to 7 feet for standard rolled pipe to 20 feet or larger for bolted round or arched pipe.

Inspection of culverts

Proper inspection is essential for safe train operations. All culverts should be inspected on a regular basis. The inspection cycle may vary from one railroad to another, from annual inspections to a five or ten year cycle, depending on traffic density, train speed and condition of the structure. More frequent inspections may be required to monitor known trouble spots. Special inspections may be required following high water or other emergencies.

It is important to make culvert inspections early in the Spring, before vegetation becomes a problem and to permit scheduling of maintenance work for the current year.

During the inspection of culverts by the Division B&B Supervisor or System Inspector, the condition of the structure should be carefully noted on a permanent inspection form. By comparing the current inspection form with those made over the last several years it is possible to monitor changes in the condition of the structure.

The inspector must learn to recognize the signs of an impending failure. These include sagging, bulging, cracking, vertical or horizontal displacement, scouring, undermining and infiltration. Unless a thorough inspection is made, the first sign of trouble may be a slide in the embankment or vertical subsidence at the ends of the ties.

Culvert maintenance

Stone and brick arches frequently experience a deterioration of mortar in the joints. The joints should be cleaned and all loose material removed. A non-shrinking grout can then be placed. When the deterioration is widespread enough, it may be necessary to replace shattered or laminated stones with cast-in-place concrete blocks or apply a shotcrete facing.

Seriously deteriorated walls may require the construction of concrete wall anchored to the wall of the culvert.

A cofferdam may be constructed to allow dewatering of the work area.

Loose stones are removed and masonry anchors are placed. The reinforcement and formwork are placed and the concrete wall

can be poured. Grouting may be done to fill any voids.

Concrete arches and box culverts can be repaired with cast-in-place concrete or shotcrete. Cracks can be sealed with grout or epoxy to prevent further damage.

When the barrel of a culvert has failed but the sidewalls are still in good condition, it is possible to notch the sidewalls at the spring line and install a structural plate liner. The void between the barrel and the liner should be pressure grouted.

Pipe culverts are prone to pull-aparts and undermining of the ends. Both of these conditions can often be attributed to improper installation. Settlement of the pipe due to improper bedding will cause the joints to open and leak. This can be corrected by jacking, grouting the void with a quick-setting concrete or installing an internally expanding band. Shallow-bury culverts can be removed and reset if track time will allow. Once repaired, cables or headwalls may be installed to prevent a recurrence.

Corrugated-metal pipes most frequently fail as a result of corrosion, particularly in the invert. This can sometimes be repaired with concrete or it may be necessary to replace the pipe.

Structural-plate culverts are subject to the same types of maintenance problems as rolled pipe along with some of their own. Improper installation can result in splitting of the plates through the bolt holes. This is caused by inadequate compaction of the fill material. To correct this situation, it may be necessary to grout in a smaller diameter liner under the live load area.

Over the years, the track bed may be raised requiring an extension to the culvert or the construction of higher headwalls and wingwalls to maintain proper sideslopes.

Waterway condition

The condition of the waterway itself is as important as the condition of the culvert. A change in the direction of flow or its velocity can contribute to partial failures of a culvert. Wingwalls can break and the barrel can break off near the end due to settlement caused by scour. Often the changes in flow are caused by a temporary obstruction such as logs or other debris. Once removed, the flow will return to normal.

Proper maintenance of the waterway will allow the culvert to carry the flow without backing up water on the upstream side or scouring on the outlet end. This includes keeping the waterway free of debris or vegetation and maintaining proper grade in the waterway. This should be kept at about one per cent. If the grade is too steep, the high velocity of the flow will damage the banks and inlet end of the culvert and scour the outlet. If the waterway has an insufficient grade, it can back up water or silt in, thus reducing the effective area of the culvert opening.

Culvert replacement

When a culvert has failed or deteriorated beyond economical repair, it becomes necessary to replace it.

Before replacement is made, the drainage requirements of the area should be carefully checked since the drainage area or land usage may have changed since the old culvert was installed. A drainage survey will provide the necessary information.

Information required for such a survey is as follows:

(1) Location Plan
   (a) Distance from nearest town, milepost and valuation chaining station along with Section, Township and Range. This information will be useful in locating the project in the event a state or federal agency will be involved or a permit required.
   (b) Shape of watershed and drainage area in acres. This information can be secured from traverse or from a dependable U.S. Coast and Geodetic Survey or county contour map. Data obtained from published maps should be verified by observation.
   (c) Average slope of watershed in percent.
   (d) Character of soil, i.e., erosive, sandy, loam, clay, gumbo, rock, etc. This information may help to determine the construction method used for replacement structure. An undesirable fill material may rule out an open-cut

installation. The presence of rock may require tunneling.

(e) Use of the watershed and percent of each usage, such as timber, pasture, cultivated or urban improvement.

(f) Natural and artificial storage such as lakes, stock ponds, reservoirs and swamps.

(g) Other railroads, highways and secondary roadways in the area including size and description of pertinent drainage structures.

(h) Elevations should be in mean sea level datum if available; otherwise, right-of-way profile datum.

(i) A larger scale location insert should be included to show relationship of track to stream including angle of crossing.

(j) If a channel is contemplated, the most favorable angle of the stream crossing should be shown along with ownership of property along both sides of the stream.

(2) Waterway Areas

(a) Elevation view of existing structure. If a bridge is to be replaced with a culvert, shown panel lengths and distances from base of rail to ground line, point of pile and rock or shale if known.

(b) Cross section of existing culvert and at location of proposed opening.

(c) Highwater elevation and date of occurrence.

(d) Elevations of backwater from stream below drainage structure, name of stream and data of occurrence.

(e) Total waterway area of existing bridge or culvert.

(f) Total effective waterway, that is below highwater elevation.

(g) Waterway areas of other railroad and highway drainage structures upstream or downstream of the bridge or culvert.

(h) Use of existing structure as underpass or cattle pass if so used.

(i) Design flow, i.e., Talbot's formula or 100-year flood.

(3) Alignment and Profile

(a) Alignment of track each side of structure.

(b) Profile of base of rail and profile or roadway ditch on upstream side within the watershed.

(c) If grade raise is involved, existing and proposed base of rail elevations should be shown.

(4) Borrow Pits

Show most feasible location of borrow site if required.

Considerations for recommendation

When this information has been secured, recommendations for replacement should be made by the Engineer, taking into consideration waterway requirements, history of drift problems, washouts, silting of waterway, condition of the outlet, the use of the structure for other than waterway requirements, changing conditions in the watershed and the requirements of government agencies.

A single-barrel culvert is preferable; however, vertical restrictions may require multiple pipes or pipe arches.

Drainage structures should be located in the channel of the waterway to obtain the greatest efficiency. Sharp turns in the channel and the ends of the culvert should be avoided. This will help to avoid liability to adjoining property owners for diversion of natural flow.

Changes in channel location on or off the right-of-way must be approved in writing by the adjacent property owners and covered by an appropriate agreement before work begins.

Threading pipe

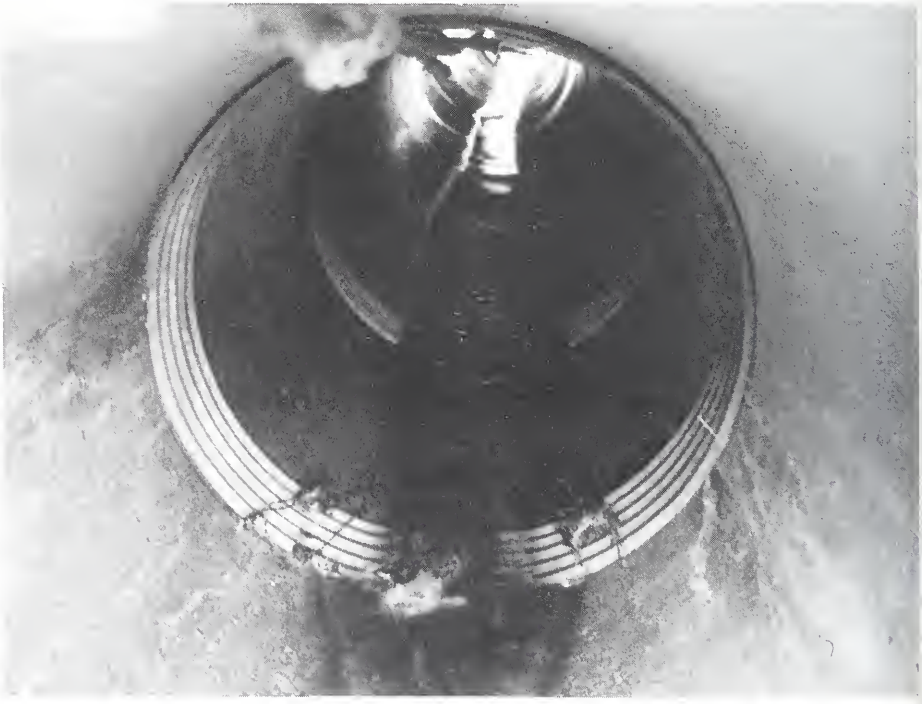
Replacement of a culvert with a small pipe threaded through and grouted in place is common practice, if the reduced opening is sufficient. Fortunately, many old culverts were built much larger than required making this type of replacement possible.

When threading is not possible, another available means is open cutting the fill section when depth, type of fill material and train traffic will permit.

High fills and heavy train traffic may necessitate the jacking of a new culvert. This

5–50′ stone arch spans with gunite liner in barrels.

Deterioration of sidewalls of stone arch.



Internal expanding bands and cable to repair a pull apart in a reinforced concrete pipe.

Cracks in shotcrete facing applied to a stone arch.

120" diameter by 96' long structural plate culvert lowered into place.

type of installation is usually expensive with most work of this type being done by contractors. Once started, the jacking procedure must be continuous to prevent "freezing" of the pipe. Various methods of jacking are used including augering, simultaneous dry bore and jacking and reaming.

The presence of rock in the fill section may require a tunneling installation. This type of work is extremely costly and labor intensive.

It is often possible to replace a bridge with one or more culverts. This can include pipes, structural plate culverts and concrete boxes.

The culverts are placed on a prepared bedding between the bents of the old bridge and fill material placed. The old bridge is removed and filling completed, taking care to properly compact the fill. The track is ballasted and surfaced to complete the job.

Occasionally, it is possible to fill and abandon a culvert entirely. This usually requires a channel change or ditching along the track.

The failure of a culvert may require the construction of a bridge due to depth, soil conditions or traffic density which may preclude any other methods of replacement. In this case, piling are driven and a "Blind" bridge constructed. When the bridge is completed, the fill and culvert can be removed.

Summary

In closing, it should be noted that culverts play an important role in the track drainage system of railroads and their roadbeds. To function properly, they must receive proper maintenance.

Inspections, done at regular intervals by trained personnel will identify problems while they are small and repairs are minor. These inspections should be kept on a permanent form so that changes in the condition of the structure can be monitored.

When it becomes necessary to replace a culvert, sufficient information should be collected to determine the type of structure to be placed taking into account adequacy and cost.

President Hyma: Thank you Mr. Ladner for another fine report. Don served as chairman of a committee on bridge inspection only two years ago. Your contributions to the work of the Association are greatly appreciated.

Again, you are reminded that reprints of this report are on the back table.

We have three directors whose terms expire this year. Mr. Bessey, Mr. Michel and Mr. Saletnik. Mr. Saletnik is not here today but I would like the other two gentlemen to come forward. As an expression of the Association's appreciation for your service I am pleased to present you with these plaques. Don—thank you. Jim—thank you.

We will now proceed with the election and installation of officers for the coming year.

The slate as presented by the Nominating Committee yesterday was as follows:

For directors—for the term expiring in 1985:

D. R. Ladner, Assistant Engineer, Chicago and North Western

R. A. Tallent, Jr., Process Engineer Structures, Southern

T. E. Kuhn, Engineer Special Projects, Missouri Pacific

For Junior Vice President:

D. A. Bessey, Assistant Chief Engineer Structures, Milwaukee Road

For Senior Vice President:

J. Budzileni, Senior Structural Designer, Illinois Central Gulf

For Treasurer:

P. H. Saletnik, Engineer Buildings, Chicago & North Western

Automatically advancing to President will be Omer C. Denz, Supervisor Building Maintenance, Milwaukee Road.

Since there were no other nominations from the floor, I will entertain a motion that these officers be elected as recommended. Is there a second? It has been moved and seconded that the slate of candidates as recommended by the Nominating Committee be elected to the offices specified. Is there any discussion? All in favor signify by saying Aye. All opposed—Nay. I hereby declare these officers duly elected. Will the new officers please stand to be recognized.

Will Bill Gallagher, President of REMSA, please come forward.

Mr. Gallagher: Thank you Walt. Mr. Denz, members of the Bridge and Building Association, ladies and gentlemen. It is a distinct pleasure for me to congratulate your Association on its selection of new officers and members of your Board.

I would certainly be remiss if I did not hank Walt Hyma and the members of his oard, and also Pat Weissmann and Joyce Grier for the excellent cooperation REMSA as received during the past year. We are ertain that this spirit of cooperation will ontinue between REMSA and Mr. Denz nd his incoming officers and directors.

As many of you know, it has been ustomary at this time each year for REMSA o present the incoming President of Bridge nd Building with a gavel, symbolic of his uthority during his term of office.

Omer, we know you are going to use this ery firmly and very wisely. Good luck.

Mr. Denz: Thank you.

Fellow officers and members of the American Railway Bridge and Building Association, it is indeed an honor to erve as President of our Association. You an be assured I will do my utmost to fulfill he President's responsibilities and provide he guidance and leadership needed to erpetuate the excellent work and programs hat have been so ably developed and rovided by this Association in the past nder leadership of very able officers and residents.

Your participation in the Association's pcoming 1983 studies, reports and programs will be needed and your efforts to rovide input and interest in the special subjects will most certainly be appreciated and helpful.

Speaking on behalf of the Association and myself, I wish to thank Walt Hyma for the outstanding work he performed as President of the American Railway Bridge and Building Association this past year. Walt not only worked long hours and diligently, but he handled his role as President at the meetings and discussions with ability and special ease which gave encouragement to others.

Walt, you did an outstanding job this past year in handling the Association's meetings and business, including the preparations for this conference. On behalf of the Association, it indeed gives me sincere pleasure to present this plaque of recognition to you.

We and the Association will continue to benefit from Walt's influence and leadership as he continues to serve on the Executive Committee.

At this time, I wish to congratulate our new Junior Vice President Don Bessey and our directors, Don Ladner, Ray Tallent and Tom Kuhn.

There will be a meeting of the new Executive Committee immediately following the close of today's session.

Does anyone have any other matters to be brought before this meeting? If not, I declare this 87th Annual Meeting adjourned.

irst row, left to right: J. M. Williams, W. R. Hyma, O. C. Denz, J. Budzileni, P. A. Weissmann; econd row, left to right: J. W. Davidson, O. D. Anthony, D. A. Bessey, D. R. Ladner, R. A. allent, D. J. Lewis, T. E. Kuhn, J. N. Michel, H. J. Laga.

Past Officers

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934–1935	1935–1936	1936–1937	1937–1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938–1939	1939–1940	1940–1941	1941–1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	. . . . .	. . . . .	F. O. Whiteman	A. G. Shaver
Treasurer	. . . . .	. . . . .	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942–1943	1943–1944	1944–1945	1945–1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

† To November 1, 1942 ‡ To February 1, 1943

	1946–1947	1947–1948	1948–1949	1949–1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950–1951	1951–1952	1952–1953	1953–1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. VonSprecken
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963	1963-1964	1964-1965	1965-1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
Directors	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966-1967	1967-1968	1968-1969	1969-1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970-1971	1971-1972	1972-1973	1973-1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	T. A. Reynolds	J. W. Chambers	R. K. Corbett	D. C. Gould
	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	J. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinsky	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

	1974–1975	1975–1976	1976–1977	1977–1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensiek	J. W. Chambers	W. J. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensiek	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammel	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	B. J. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammel		W. S. Stokely

	1978–1979	1979–1980	1980–1981	1981–1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	J. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	D. J. Lewis
	L. D. Green	D. A. Bessey	O. D. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither endorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1.* The membership of this association shall be divided into four classes, viz: Members, life members, associate members and honorary members.

Section 2.* A member shall be a person in a position above rank of gang foreman in connection with engineering, construction and maintenance for railway bridges, buildings and water service facilities: or in the employ of a public regulatory body, a professor of engineering or architecture, a technical editor, a government or private timber expert, a consulting engineer, or an engineer in his employ, engaged in the engineering, construction and maintenance of railroad-related facilities or an engineer employed by a technical service or research and development organization, an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this association. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least 15†† years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article.

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*Amended September, 1976.
**Amended September 20, 1948
††Amended March 10, 1958.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8.** Only members shall hold office in this association, and only members and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1‡‡. The officers of the Association shall be a President, two Junior Vice Presidents, a Senior Vice President, a Treasurer and nine Directors, who, with the most recent Past President, shall constitute the Executive Committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any member of the

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*Amended October 16, 1941.
†Amended September 21, 1957.
‡Amended September 28, 1966.
‡‡Amended September 20, 1978.
° Amended October 7, 1982.

association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2††. The President, two Junior Vice Presidents, and Treasurer shall hold office for one year and the Directors for three years; three Directors being elected each year. The Senior Vice President shall hold office for one year and ascend to the office of President at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A Director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3.° The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4.° The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5.° The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1†. Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears, may be stricken from the list of members at the discretion of the executive committee.

Section 2.‡ A person stricken from the list of members because of non-payment of dues, upon written application may be reinstated as a member in his former class without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the executive committee voting in the manner prescribed in Section 2, Article III.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the executive committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

3. It shall be within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

***DUES

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:°

Members, $12.00; Associate Members, $12.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7.‡‡ The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President and discharge his duties in case of a vacancy in his office. The Senior Vice President shall have the senior position of Vice Presidents.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.# After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

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‡Adopted October 17, 1940.
#Amended December 4, 1950.
†Amended September 20, 1948.
‡Amended September 21, 1957.
‡‡Amended September 20, 1978.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to cooperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDERS OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called executive committee meeting.

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†Amended September 20, 1948.
*Article adopted 1922.
**Amended September 20, 1948.
‡Amended September 21, 1957.
***Amended September 15, 1965.
° Amended April 1, 1982.

DIRECTORY OF MEMBERS

As of Feb. 15, 1982

HONORARY MEMBERS

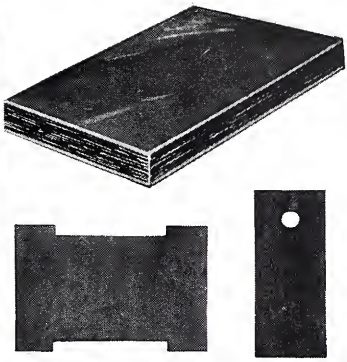
Benson, G. W.
Dick, M. H.
Dove, R. E.
Gunderson, R. R.
Huffman, W. H.
Jorlett, J. A.
Schlaf, E. R.

LIFE MEMBERS

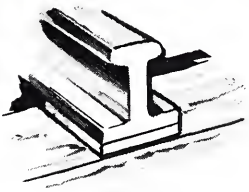
Armstrong, W. F.
Arnold, L. K.
Baker, F. A.
Barr, A. S.
Barsema, M.
Beaver, J. F.
Bell, D. V.
Beringer, M. A.
Bishop, D. B.
Boehling, H. A., Jr.
Bowman, R. M.
Bradfield, R. G.
Buckmaster, W. A.
Bunge, W. H.
Burch, E. E.
Burleson, H. S.
Burpee, C. M.
Camelle, E. J.
Carlson, A. W.
Carter, J. W.
Celander, H. W.
Chamberlain, P.
Christianson, H. B.
Clark, W. H.
Cooper, S. A.
Cross, E. T.
Cummins, C. P.
Davis, H. E.
DeValle, J. W.
Dixon, C. E.
Duchac, J. V.
Eargle, J. M.
Eichenlaub, C. M.
Elliott, C. E.
Enstrom, W. A.
Erskine, J. A.
Forseth, C. E.
Fort, O. E.
Fox, R. L.
Gipson, C. G
Goforth, J. A.
Hawley, I. H.
Hedley, W. J.
Hellweg, R. D.
Hendrix, W. P.
Hickok, B. M.
Hodgkins, E. W.
Hogel, E. C.
Howard, J. G.
Howe, A. K.
Hornig, F. F.
Hubbard, M. J.
Humphreys, R. W.
Hunter, A. L.
Hutcheson, T. B.
Hutcheson, W. A.
Hutto, J. E.
Jackson, T. E.
Jenkins, H. W.
Johnson, A. C.
Johnson, E. A.
Johnson, H. T.
Jones, W. J.
Kendal, J. T.
Kieckers, E. W.
Kvënberg, S. E.
Laurick, M. J.
Leach, A. L.
Linn, G. A.
Little, H. C.
Lokotzke, G. P.
Lowry, J. M.
Lund, C. V.
Mabry, D. B.
Martens, W. F.
Martin, J. W.
Messman, D. V.
Meyers, B. R.
Moore, I. A.
Moris, R. F.
Myers, E. T.
Myers, R. L.
Oest, W. C.
Ostrom,W. D.
Packard, B. G.
Pahl, W. H., Jr.
Patterson, C. C.
Patterson, C. A.
Patterson, J. M.
Perrier, J. L.
Peterson, N. E.
Presthus, E. J.
Pritchard, B. L.
Prude, G. F.
Raessler, V. D.
Rainey, W. H.
Rankin, W. H.
Rees, F. L.
Reger, J. H.
Robinson, G. E.
Rothell, R. D.
Runde, E. E.
Safley, J. R.
Salmon, J. M., Jr.
Sathre, C. O.
Saunders, T. D.
Schmitz, J. F.
Seley, L. L.
Seltzer, J. W.
Shamblin, R. E.
Short, W. L.
Simonson, E. F.
Sinclair, C. H.
Slagle, G. P.
Smith, H. E.
Smith, J.
Smith, R. H.
Switzer, G.
Tardy, F. E.
Taylor, W. L.
Termunde, W. L.
Tetreault, L. J.
Thatcher, C. H., Jr.
Throckmorton, W. B.
Trulove, J. D.
Tucker, N. R.
Tustin, E. O.
Tyckoson, E. G.
Tyler, W. R., Jr.
VanScoyoc, L.
Von Behren, G.
Wachter, C. E.
Wall, R.
Wang, A. B.
Warfield, H., Jr.
Warfield, W. B.
White, S.
Whitehouse, B. M.

Alert 15175

SHOCK PADS for Bridges & Structures



Bridges



Railroads

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Available in almost any shape, shock pads are the least expensive way to minimize the detrimental effects of shock wherever concrete meets steel . . . or steel meets steel. For maximum strength, Alert 15175 Shock Pads are laminated from cotton duck frictioned with a special neoprene compound and offer superior weather resistance. Ideally suited to most construction applications, they are quick and easy to install and never need replacement due to deterioration from weathering. Temperature ranges from —50°F to 200°F have virtually no effect on Alert Shock Pads.

Both highway and railway bridges require shock pads to prevent structural fatigue caused by vibration. Rugged Alert Shock Pads give the necessary cushioning on bridge bearings and on mechanical expansion devices for either steel or reinforced concrete bridges.

Alert Shock Pads meet AASHO Specifications for preformed fabric pads and comply with MIL C-882 C.

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ALERT *manufacturing and supply co.*

1848 Wilmot Avenue • Chicago, Ill. 60647
Phone: (312) 452-6480

ALPHABETICAL LIST OF ALL MEMBERS

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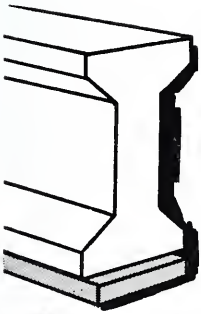

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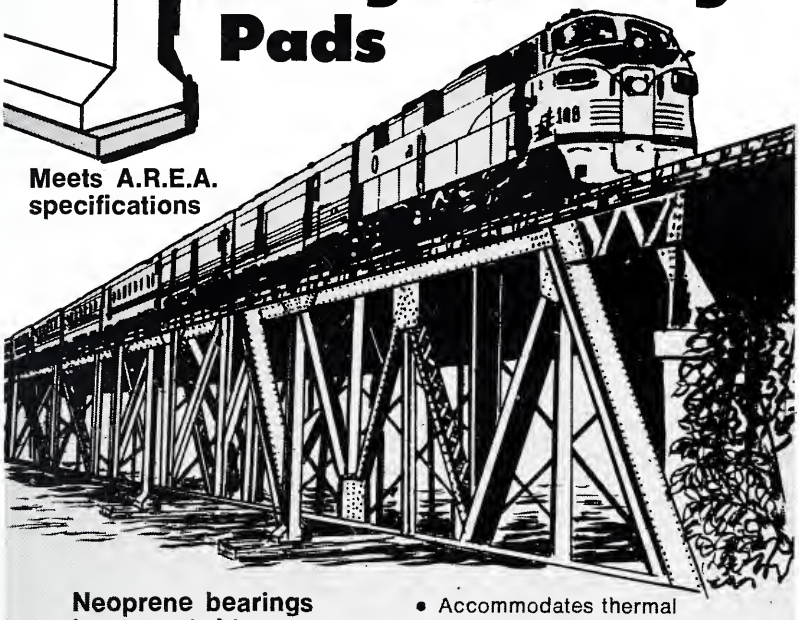

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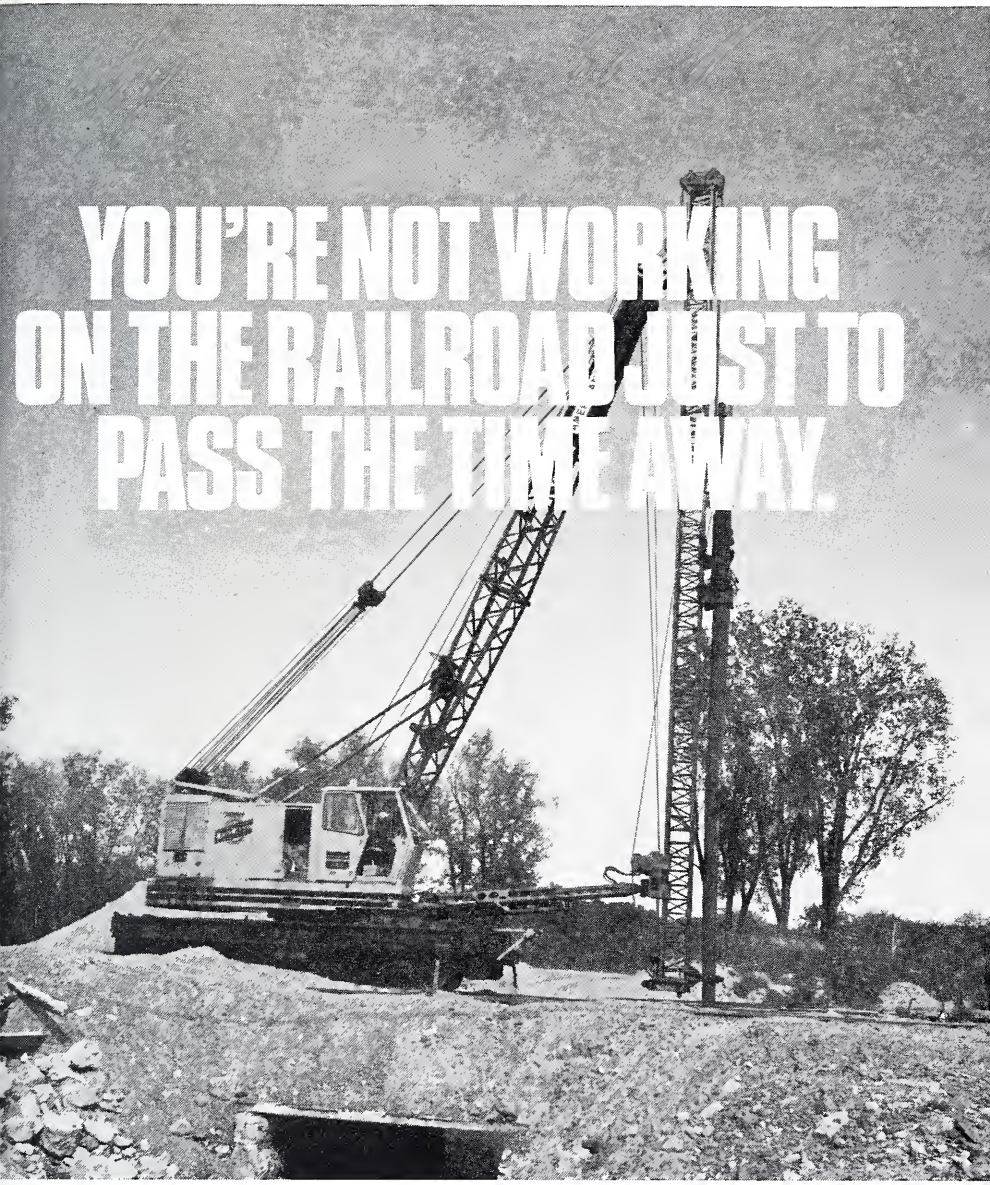

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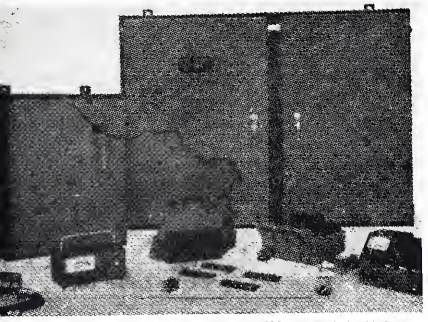

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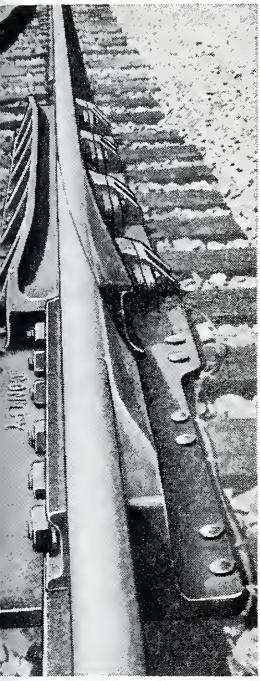

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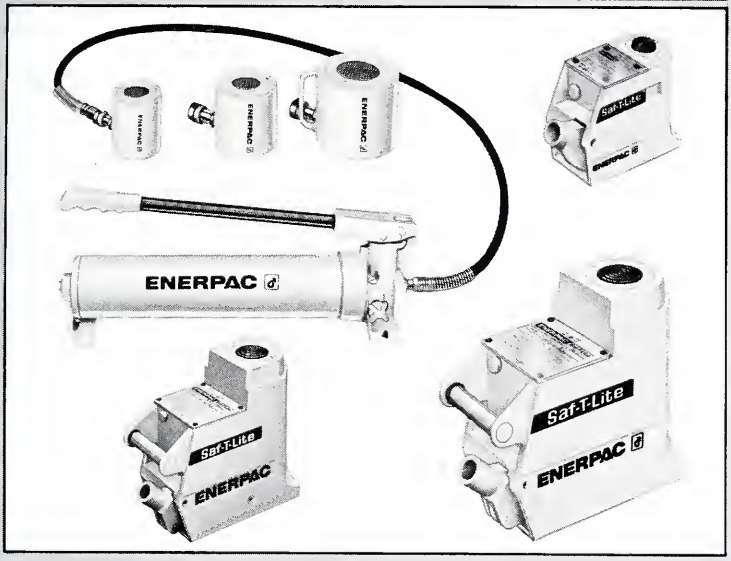

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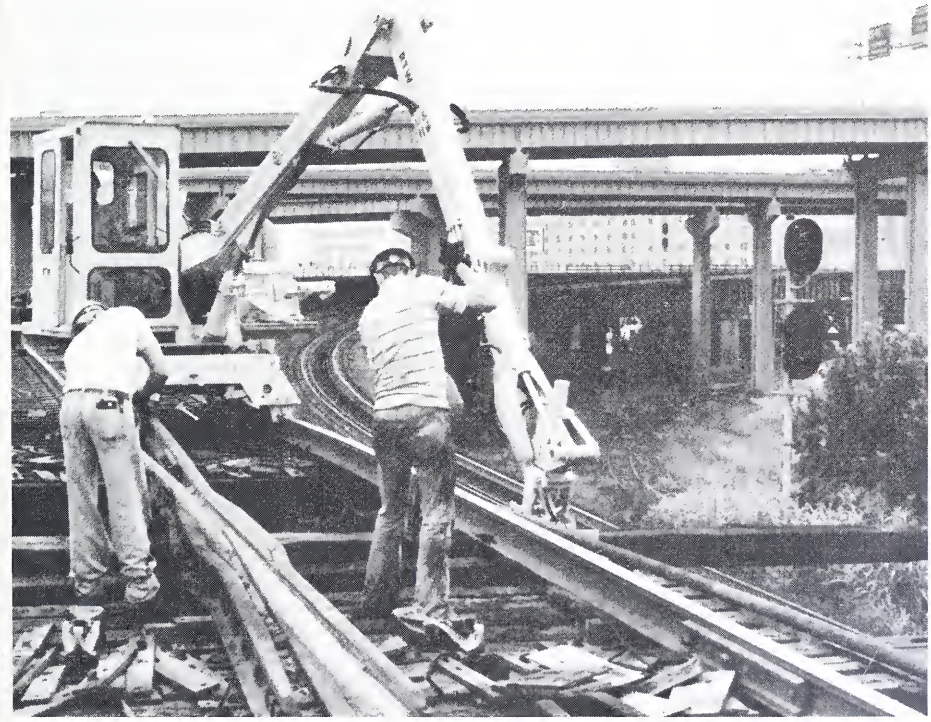

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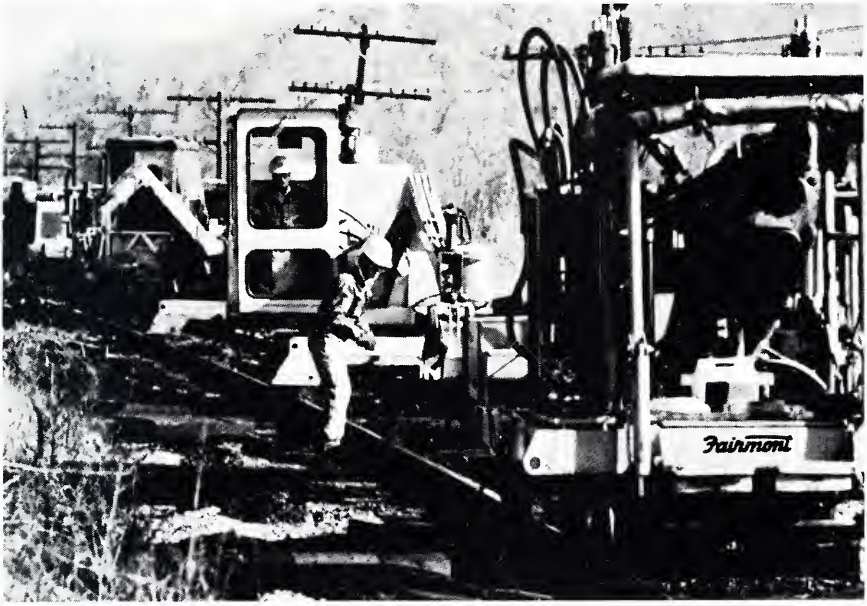

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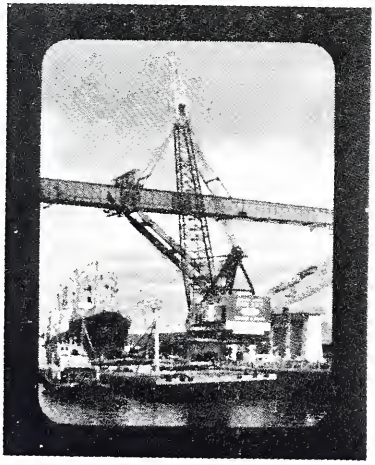

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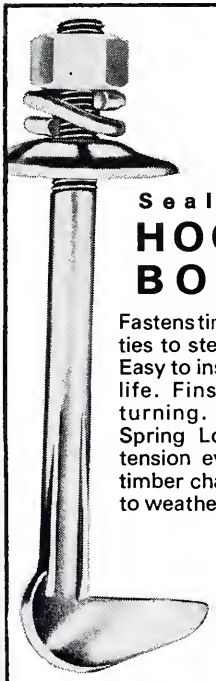

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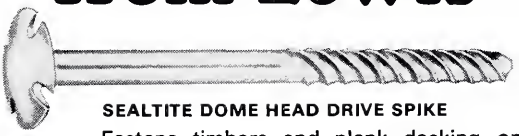

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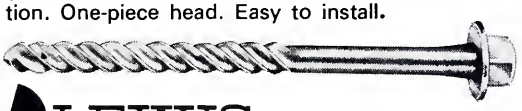

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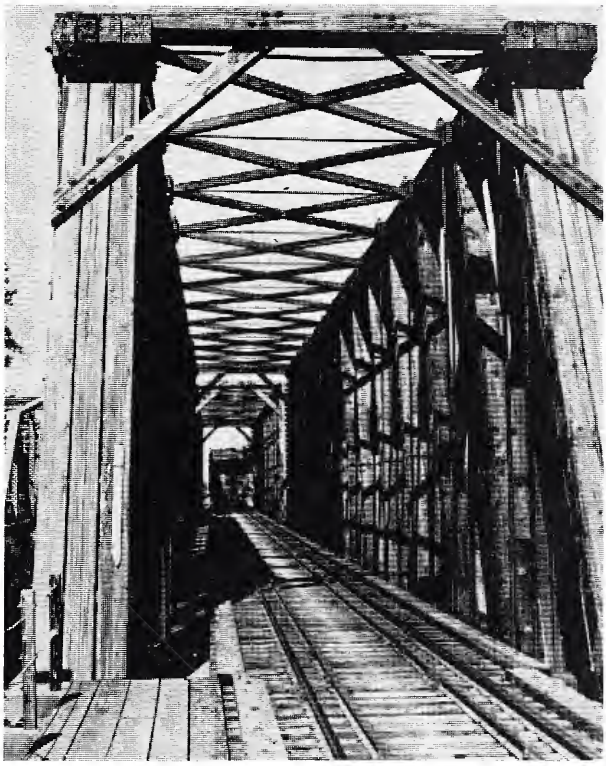

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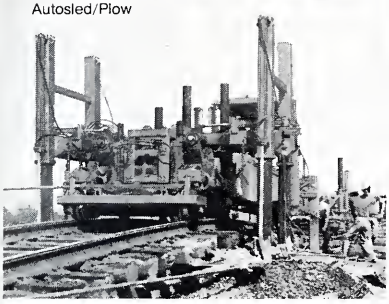

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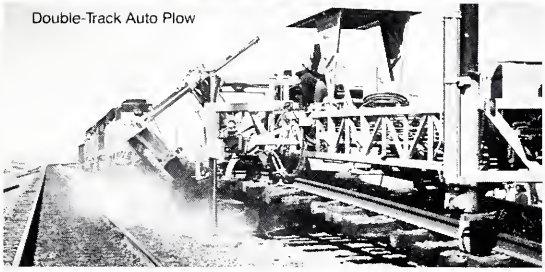

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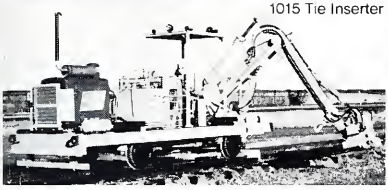

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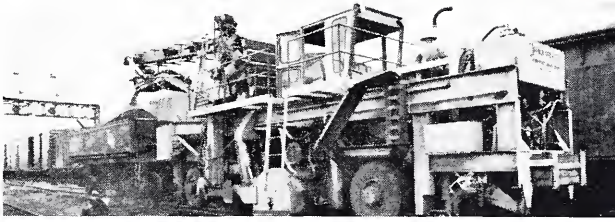

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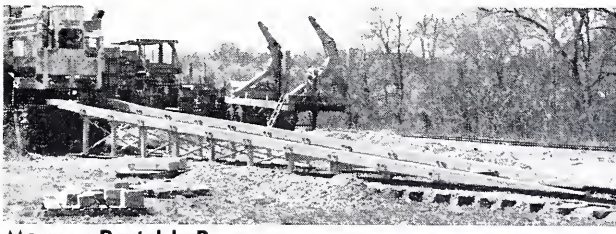

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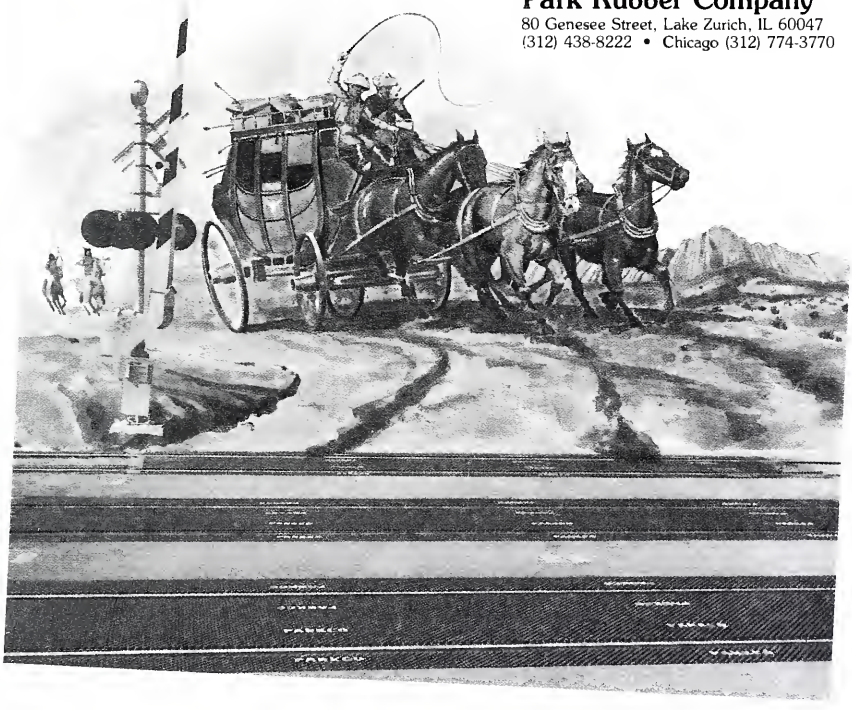

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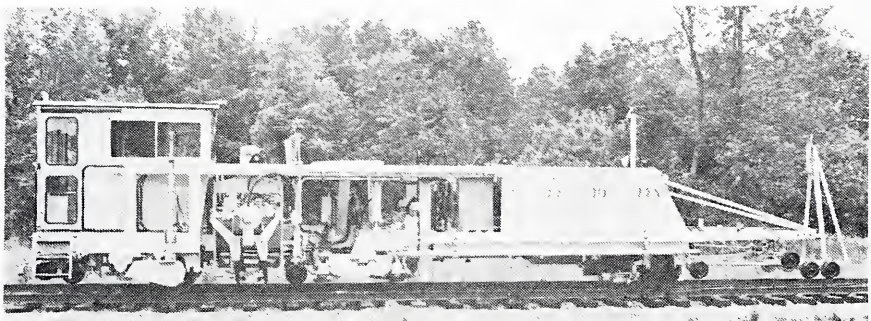

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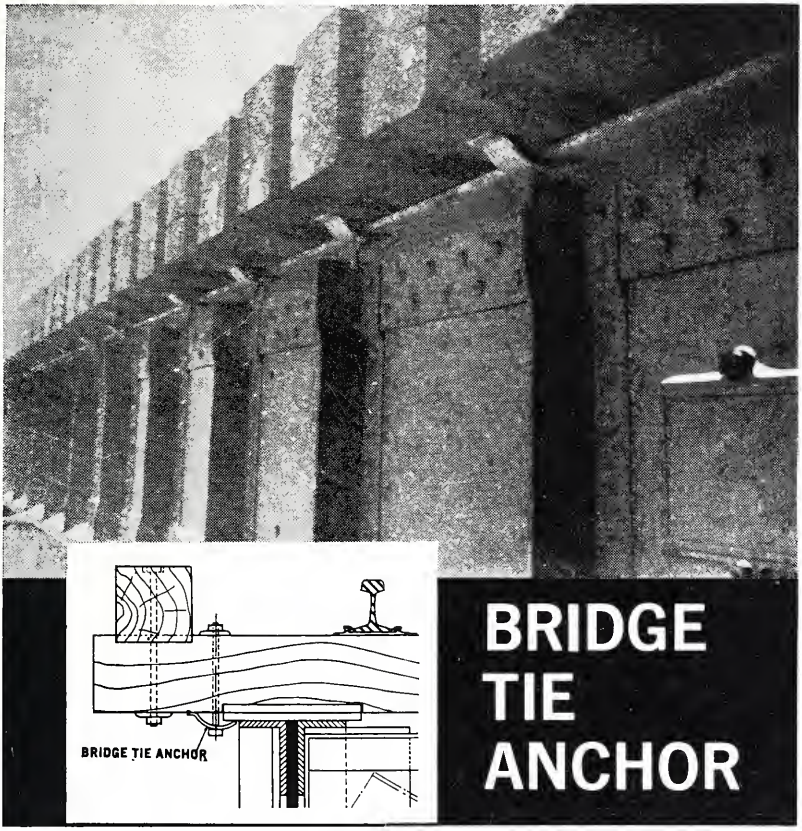

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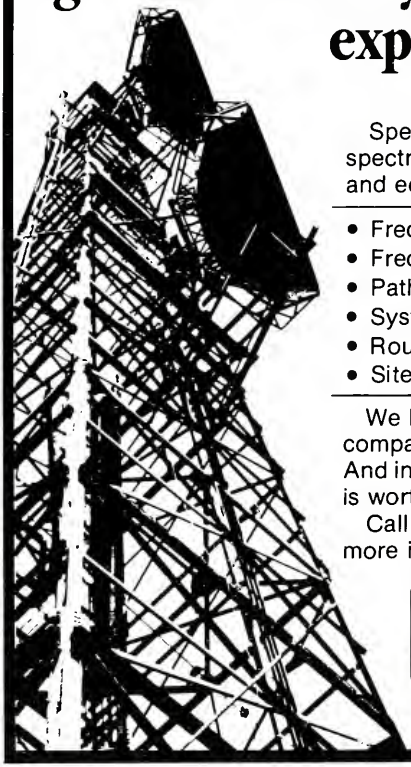

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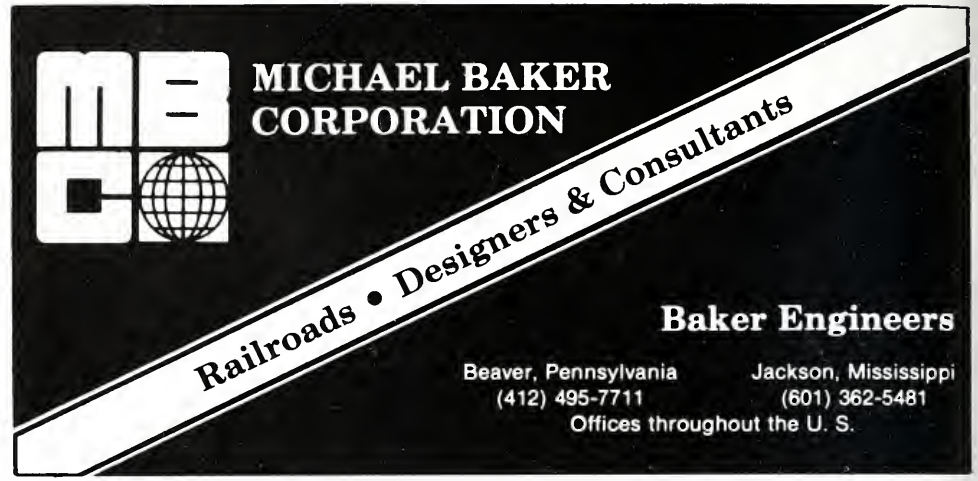

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